

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INFINERA CORPORATION,
Petitioner,

v.

OYSTER OPTICS, LLC,
Patent Owner.

IPR2020–00325¹
Patent 6,665,500 B2

Before JAMESON LEE, PATRICK M. BOUCHER, and
JOHN R. KENNY, *Administrative Patent Judges*.

KENNY, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Claims Unpatentable
35 U.S.C. § 318(a)

¹ Cisco Systems, Inc., which filed a petition in IPR2020-01347, has been added as a petitioner in this proceeding.

I. INTRODUCTION

Infinera Corporation (“Petitioner”) filed a Petition (Paper 3, “Pet.”) requesting an *inter partes* review of claims 1, 2, 4–9, and 17–19 (“the challenged claims”) of U.S. Patent No. 6,665,500 B2 (Ex. 1001, “the ’500 patent”). Oyster Optics, LLC (“Patent Owner”) filed a Preliminary Response (Paper 8, “Prelim. Resp.”). On June 26, 2020, we instituted *inter partes* review of the challenged claims.

Patent Owner subsequently filed a Patent Owner’s Response (Paper 20, “PO Resp.”). Petitioner filed a Reply to Patent Owner’s Response (Paper 24, “Pet. Reply.”), and Patent Owner filed a Sur-Reply (Paper 29, “PO Sur-reply”). At the parties’ request (Papers 26, 27), an Oral Hearing was held on March 30, 2021, a transcript of which is included in the record. Paper 33 (“Tr.”).

For the reasons discussed below, we determine that the Petitioner has proven by a preponderance of the evidence that claims 1, 2, 4, 6–9, and 17–19 are unpatentable, but has not proven by a preponderance of the evidence that claim 5 is unpatentable.

A. Related Matters

The parties identify the following related litigation: *Oyster Optics, LLC v. Infinera Corporation, et al.*, 2:19-cv-00257-JRG (E.D. Tex.). Pet. 75; Paper 5, 2.

Further, after institution in this proceeding, Cisco Systems Inc. (“Cisco”) filed a substantially identical petition challenging claims of the ’325 patent and requested joinder with Petitioner. *See* IPR2020-01347 (“’1347 IPR”), Papers 2–3. We instituted trial in the ’1347 IPR and joined Cisco as a party to this proceeding. *See* ’1347 IPR, Paper 10.

B. The '500 Patent

The '500 Patent is directed to “transmitters and receivers for fiber optic networks.” Ex. 1001, 1:8–10. The Specification discloses that fiber optics commonly transmit amplitude-modulated signals, but amplitude-modulated signals are susceptible to tapping. *Id.* at 1:12–29. According to the Specification, phase-modulated signals are more secure, but the prior-art phase-modulated systems are not “compatible with existing receivers.” *Id.* at 2:20–23. An object of the '500 patent “is to provide a transmitter for transmitting either phase-modulated or amplitude-modulated optical signals.” *Id.* at 2:26–28. The disclosed transmitter “permits a phase-modulated transmission mode, an amplitude-modulated transmission mode, [and] both a phase and amplitude modulated transmission mode.” *Id.* at 2:41–45. In the phase-modulated transmission mode, a controller phase-modulates light as a function of an output delayed-feedback exclusive-or gate having an electronic data stream as an input. *Id.* at 2:48–51. In the amplitude-modulated transmission mode, a controller can modulate the light either in direct relation to an input data stream (direct amplitude-modulated mode) or as a function of an output delayed-feedback exclusive-or gate having an electronic data stream (delayed amplitude-modulated mode). *Id.* at 2:63–3:1.

“The controller preferably has two circuits, a first circuit for controlling the phase modulation and a second circuit controlling the amplitude modulation.” Ex. 1001, 3:12–14. “Preferably, a switch . . . is provided to activate the [phase-modulated] mode, the delayed [amplitude-modulated] mode, or the direct [amplitude-modulated] mode.” *Id.* at 3:14–17. The switch can be controlled by the operator or by bit data in a packet

of the packet-based data stream. *Id.* at 3:17–22. “Both the operator-set and packet-switched systems have the advantage that telecommunications providers can provide customers differentiated services, for example a secure mode and a non-secure mode, although the bit-based method provides carriers more options for devising service levels.” *Id.* at 3:35–39.

Dual-mode transmitter 10 in Figure 1 is reproduced below (Ex. 1001, 4:56–58):

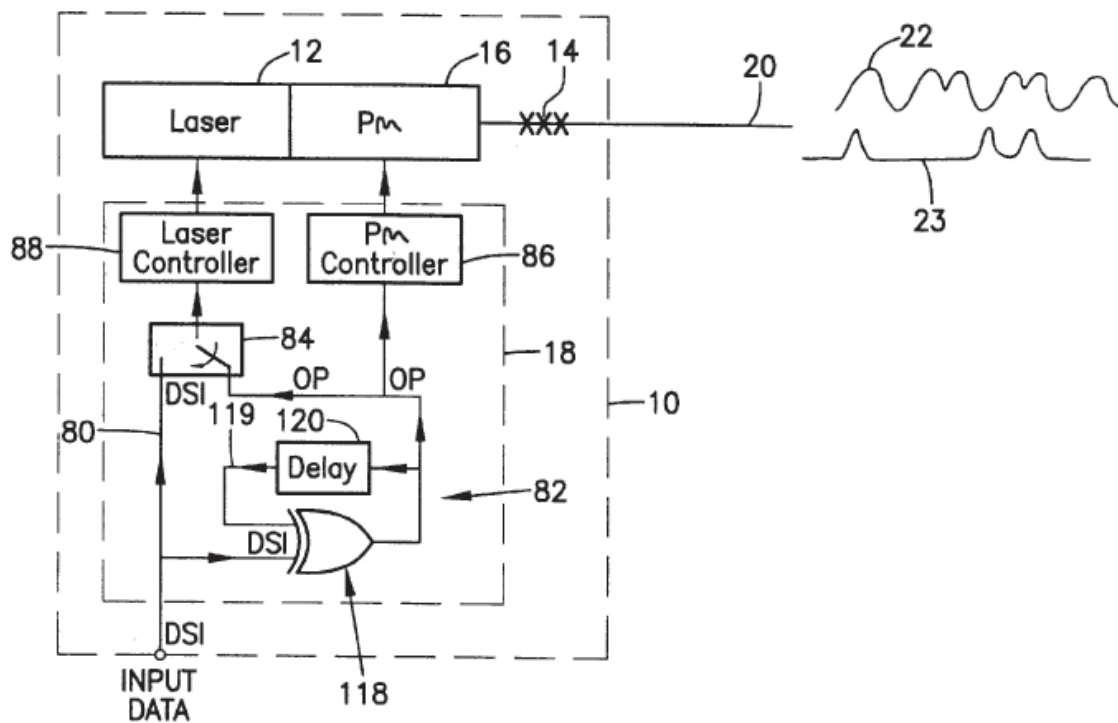


Fig. 1

As shown, transmitter 10 includes laser 12, phase modulator 16, and electronic controller 18. Ex. 1001, 4:56–67. Controller 18 includes direct amplitude modulation circuit 80, circuit 82, switch 84, phase modulator controller 86, and amplitude controller 88 (labelled as laser controller 88 in

the figure). *Id.* at 5:1–17. Circuit 82 includes delayed-feedback exclusive-or gate 118, feedback loop 119, and electronic delay circuit 120. *Id.*

In the phase modulation mode, amplitude controller 88 directs laser 12 to emit constant wavelength, non-pulsed light. Ex. 1001, 5:34–37. Depending on the output of circuit 82, “phase modulator 16 then either imparts a known initial phase shift to the light which could be 0 degrees or else imparts another known offset phase shift 40 preferably equal to the known initial phase shift +180 degrees on the light passing through phase modulator 16.” *Id.* at 5:37–42. This modulation creates phase-modulated optical signal 22, which provides a secure transmission mode. *Id.* at 5:42–48.

In the amplitude-modulation mode, amplitude controller 88 modulates the output of laser 12, producing amplitude-modulated signal 23. Ex. 1001, 5:14–20. During this mode, “phase modulator controller 86 either does not phase modulate the light, or phase modulates based upon the output of the delayed feedback exclusive-or circuit 82.” *Id.* at 5:21–25. In the delayed amplitude modulated mode, the output of delayed feedback exclusive-or gate 118 controls the amplitude modulation. *Id.* at 5:25–30. In the direct amplitude-modulated mode, amplitude modulation is a direct function of the input electronic data DSI for transmitter 10. *Id.* at 5:30–34.

C. Claims

Claims 1 and 17, reproduced below, are the independent, challenged claims:

1. An optical data transmitter comprising:
a laser;

a phase modulator for phase modulating light from the light source; and

a controller having an input for receiving an electronic data stream, the controller in a first mode controlling the phase modulator so as to create phase-modulated optical signals in the light from the laser as a function of the electronic data stream and the controller in a second alternate mode amplitude-modulating the light from the laser as a function of the electronic data stream, the first mode and the second mode occurring at different times.

17. A method for transmitting optical data in two modes comprising the steps of:

phase modulating light from a laser during a first transmission mode so as to transmit phase-modulated optical data; and

amplitude modulating light from the laser during a second alternate transmission mode so as to transmit amplitude-modulated optical data, the second alternate transmission mode occurring at a time separate from the first transmission mode.

Ex. 1001, 8:27–43, 10:12–22.

D. Asserted Grounds of Unpatentability

Petitioner asserts the following grounds of unpatentability:

Ground	References/Basis	35 U.S.C. §	Claims Challenged
1	Barr ² and Hofstetter ³	103(a) ⁴	1, 2, 4, 6–9, 17–19
2	Sasaki ⁵ and Ishii ⁶	103(a)	1, 2, 4, 17–19
3	Sasaki, Ishii, Davarian ⁷	103(a)	5

Pet. 2. Petitioner also relies on Declarations from its expert, Dr. Jack Winters (Ex. 1003 (First Declaration), Ex. 1024 (Supplemental Declaration)). Patent Owner relies on a Declaration from its expert, Mr. Joseph C. McAlexander III, P.E. (Ex. 2005).

² U.S. 4,763,357, issued Aug. 9, 1988 (Ex. 1005, “Barr”).

³ U.S. 5,903,376, issued May 11, 1999 (Ex. 1006, “Hofstetter”).

⁴ The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–288 (2011), amended 35 U.S.C. § 103. Because the application from which the ’500 patent issued was filed before March 16, 2013, the effective date of the relevant amendment, the pre-AIA version of § 103 applies.

⁵ U.S. 6,486,992 B1, issued Nov. 26, 2002 (Ex. 1009, “Sasaki”).

⁶ Y. Ishii, K. Tsukamoto, S. Komai, and N. Morinaga, “Coherent Fiber-Optic Microcellular Radio Communication System Using a Novel RF to-Optic Conversion Scheme,” IEEE Transactions on Microwave Theory and Technique, vol. 45, no. 9, pp. 2241-2248, September 1995 (“Ishii”).

⁷ F. Davarian and J. Sumida, “A Multipurpose Digital Modulator,” IEEE Communications Magazine, vol. 27, no. 2, pp. 36-45, February 1989 (Ex. 1011, “Davarian”).

II. ANALYSIS

A. Level of Ordinary Skill

Dr. Winters testifies that an ordinarily skilled artisan would have had a bachelor's degree in electrical or electronics engineering, optical engineering, physics, or the like, and two years of optical communications experience. Ex. 1003 ¶ 7. Dr. Winters also testifies that someone with less technical education but more experience, or more technical education but less experience, could have also been an ordinarily skilled artisan. *Id.*

Mr. M^cAlexander testifies that an ordinarily skilled artisan would have had a bachelor's degree or equivalent in electrical engineering and two or more years of experience in the design and/or implementation of transmitter/receiver components. Ex. 2005 ¶ 23. Mr. M^cAlexander also testifies that the ordinarily skilled artisan would have had knowledge of such transmitter/receiver components as would apply to electrical and optical applications. *Id.* Mr. M^cAlexander further testifies: “[f]or example, [an ordinarily skilled artisan] would have education and/or experience sufficient to understand optical components for encoding, transmission, and decoding of data and related standards and concepts.” *Id.* Mr. M^cAlexander testifies further that his analyses and opinions would not change if Dr. Winter's definition of an ordinarily skilled artisan were to be accepted. *Id.* ¶ 25.

Based on the full record before us, we see no reason to disturb our preliminary finding regarding the level of ordinary skill in the art in our Institution Decision, in which we adopted Dr. Winter's definition. Inst. Dec. 8–9. Accordingly, we reaffirm that an ordinarily skilled artisan would have had a bachelor's degree in electrical or electronics engineering, optical

engineering, physics, or the like, and two years of optical communications experience. Ex. 1003 ¶ 7; Inst. Dec. 8–9. Someone with less technical education but more experience, or more technical education but less experience, could have also been an ordinarily skilled artisan. Ex. 1003 ¶ 7; Inst. Dec. 8–9.

The difference between the experts’ definitions of an ordinarily skilled artisan, however, would not affect our analysis. We would reach the same conclusions if we were to adopt Mr. McAlexander’s definition.

B. Claim Construction

We construe claims using the same claim construction standard “that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b) (2019).

1. Proposed Terms for Construction

Petitioner proposes that we construe (i) the phrase “amplitude modulating [] light from the laser,” recited in claims 1 and 17; (ii) the phrase “as a function of the electronic data stream,” recited in claim 1; (iii) the phrase “in direct relation to the input data stream,” recited in claim 2; and (iv) the phrase “a switch for switching between the first and second modes,” recited in claim 4. Pet. 6–10. Patent Owner does not propose the construction of any term. PO Resp., generally. We determine that only the phrase “in direct relation to the input data stream” requires construction. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

2. in direct relation to the input data stream

Petitioner proposes construing “in direct relation to the input data stream” as “amplitude modulating light as a function of the input data stream without using an output of delayed-feedback exclusive-or gate.”

Pet. 9. (In claim 2, the words “amplitude modulates the light” precede the phrase “in direct relation to the input data stream.” Ex. 1001, 8:42–44.)

Patent Owner opposes Petitioner’s proposed construction, but offers no alternative construction. PO Resp. 39–41.

Petitioner argues that the following passages from the ’500 patent support its proposed construction:

[T]he light may be amplitude modulated *either in direct relation to an input data stream . . . or as a function of an output of a delayed feedback exclusive-or gate* having the electronic data stream as an input . . . The amplitude modulating step may include amplitude modulating the light *as a direct function of an input electronic data stream*, or as a function of an output of a delayed-feedback exclusive or gate.

Pet. 9 (emphasis added by Petitioner) (quoting Ex. 1001, 2:63–3:1, 4:23–26, citing *Id.*, Fig. 1). Petitioner also offers the testimony of Dr. Winters in support of this construction. Ex. 1003 ¶ 49.

Patent Owner argues that Petitioner’s proposed construction fails to give meaning to the word “direct.” PO Resp. 39. Patent Owner also argues that Petitioner’s proposed construction relies on an unproven assertion that the only way to achieve indirect amplitude modulation of light is by using a delayed-feedback exclusive-or gate, or that a reference that does not expressly disclose a delayed-feedback exclusive-or gate must inherently

employ direct modulation. *Id.* Patent Owner offers no expert testimony to support its arguments regarding the construction of “in direct relation to the input data stream.” *Id.* at 39–40.

We addressed the same arguments by the parties regarding the construction of the phrase “in direct relation to the input data stream” in our Institution Decision. Inst. Dec. 10–11. In particular, the Patent Owner Response substantively repeats the claim construction arguments for this phrase that were presented in the Preliminary Response. *Compare* Prelim. Resp. 34–36 *with* PO Resp. 39–40.

In our Institution Decision, we accepted Petitioner’s proposed construction for this phrase. Inst. Dec. 10–11. We held that Petitioner demonstrated support for the construction in the Specification, and Patent Owner offered no alternative construction nor any evidence indicating that Petitioner’s proposed construction was erroneous. *Id.* We also disagreed with Patent Owner’s argument that Petitioner’s proposed construction does not give meaning to the word “direct.” *Id.* We held that the proposed construction excludes amplitude modulation with a delayed feedback exclusive-or gate, thereby giving a particular meaning to the word “direct.” *Id.* at 10. Further, we determined that although Patent Owner argued that indirect amplitude modulation encompasses more than just the lack of use of a delayed-feedback exclusive-or gate, Patent Owner provided no supporting evidence for that argument and did not identify any indirect amplitude modulation that lacks a delayed feedback exclusive-or gate. *Id.* We declined to speculate whether Patent Owner could support such an argument. *Id.* We accepted Petitioner’s proposed construction, but noted that a more complete record with a proposed construction by each party and

support for each party's construction, would be helpful for the construction of this phrase for the Final Written Decision. *Id.*

Nevertheless, Patent Owner does not offer an alternative construction, does not identify any indirect amplitude modulation that lacks a delayed feedback exclusive-or gate, and does not provide any support for its argument that indirect amplitude modulation encompasses more than the lack of a delayed feedback exclusive-or gate. PO Resp. 39–40.

As we held in the Institution Decision, the Specification supports Petitioner's proposed construction. Ex. 1001, 2:63–3:1, 4:23–26; Inst. Dec. 10–11. Petitioner's proposed construction is also supported by the testimony of Dr. Winters. Ex. 1003 ¶ 49. Further, as mentioned, Patent Owner presents no contrary expert testimony. PO Resp. 39–40. Whether we would adopt or modify Petitioner's proposed construction if we had a record with evidence indicating that the proposed construction improperly included or excluded subject matter is not an issue before us. On the record before us, we will not speculate based on mere attorney argument that the proposed construction encompasses subject matter it should exclude or includes subject matter that it should exclude. Petitioner supports its proposed construction, and Patent Owner does not support its opposition to that construction. Pet. 9; PO Resp. 39–40.

With this record, we construe “in direct relation to the input data stream” as “amplitude modulating light as a function of the input data stream without using an output of delayed-feedback exclusive-or gate.”

C. Asserted Obviousness

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are “such that the

subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

Additionally, the obviousness inquiry typically requires an analysis of “whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) (requiring “articulated reasoning with some rational underpinning to support the legal conclusion of obviousness”)); see *In re Warsaw Orthopedic, Inc.*, 832 F.3d 1327, 1333 (Fed. Cir. 2016) (citing *DyStar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co.*, 464 F.3d 1356, 1360 (Fed. Cir. 2006)).

1. Secondary Considerations of Nonobviousness

Neither party presents any evidence or argument regarding secondary considerations of non-obviousness relating to any challenged claim. Thus, we do not address any secondary considerations of non-obviousness in our analysis for this Decision.

2. Asserted Obviousness Based on Barr and Hofstetter

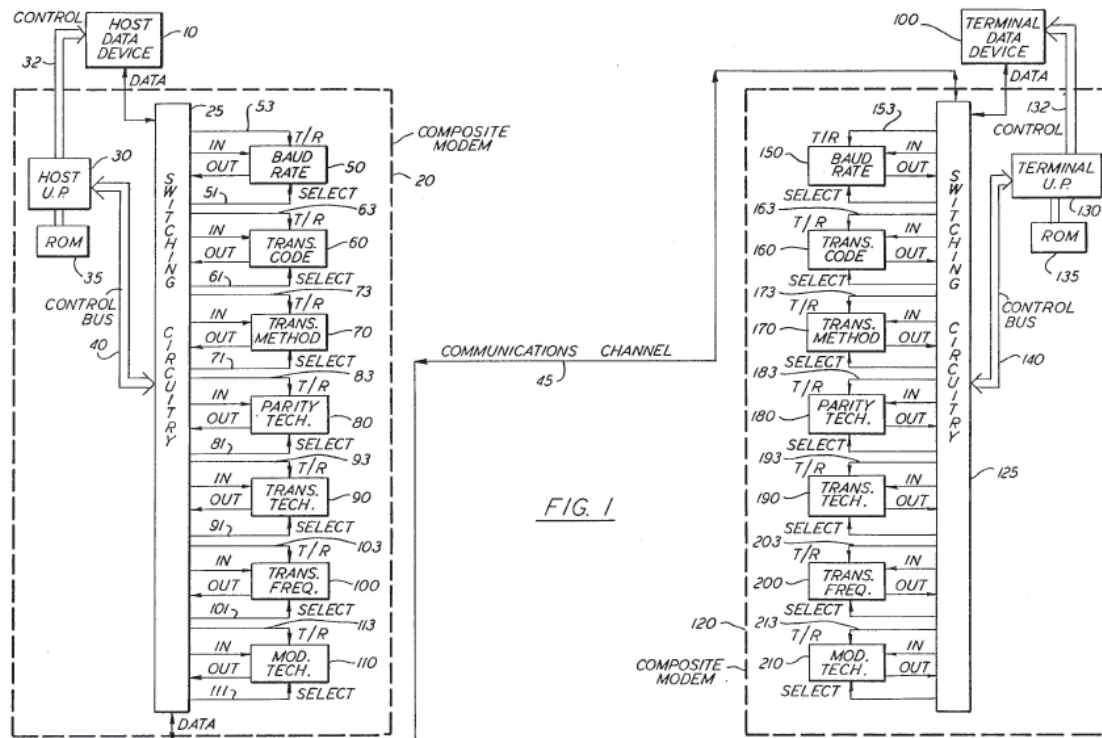
Petitioner asserts that claims 1, 2, 4, 6–9, and 17–19 would have been obvious over the combination of Barr and Hofstetter. Pet. 10–49.

a. Barr

Barr is directed to “providing secure electronic communications over a communication channel.” Ex. 1005, 1:6–10. Barr’s methods and apparatus “may be used with a large number of information transmission systems, whether the communications channel is a wire (dedicated as well as standard telephone line), or wireless (radio or microwave and of any modulation technique, for example, AM, FM or phase modulation).” *Id.* at 1:23–29. Also, Barr’s methods and apparatus can be applied “to communications channels wherein fiber optic links provide the transmission medium.” *Id.* at 1:29–32.

Barr discloses “varying the characteristics of the signal transmitted over the communications channel” to ensure the integrity of data transmission. *Id.* at 1:52–58. In this regard, “[t]he characteristics of the communications channel are varied by selecting, from amongst a plurality of data transmission protocols, the particular transmission protocol to be used at any one time.” *Id.* at 1:58–62.

Barr discloses composite modems communicating over a communication channel, as illustrated in Figure 1 below:



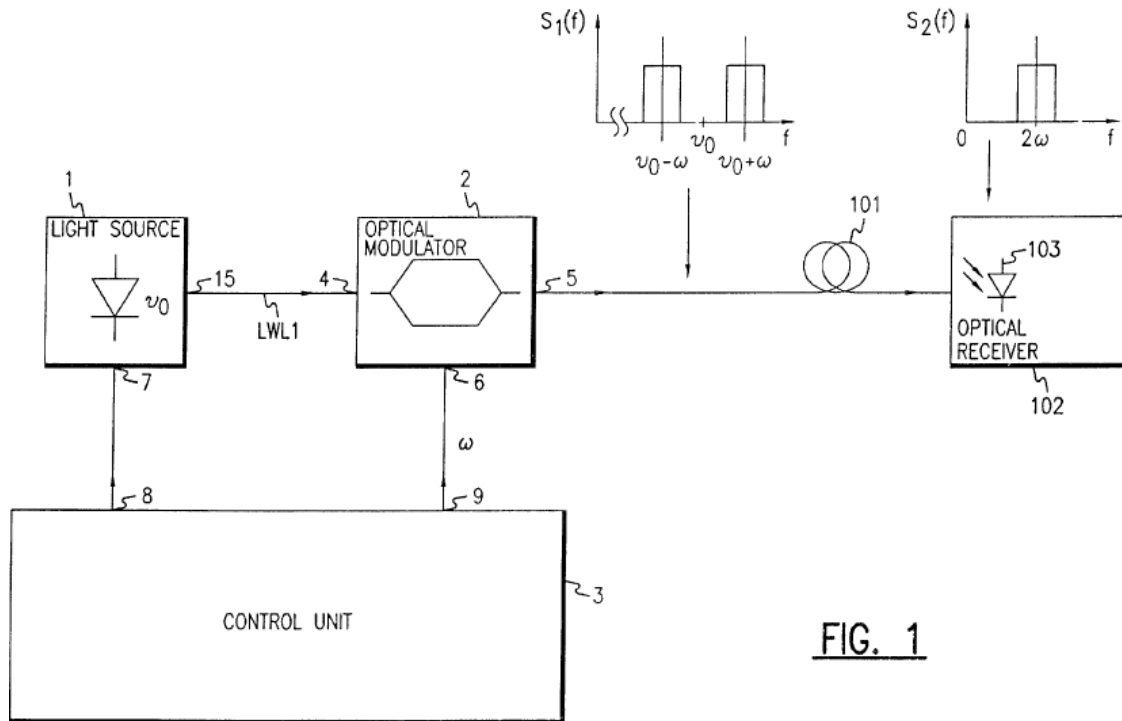
As shown in Figure 1, composite modem 20 communicates with composite modem 120 via communications channel 45. Ex. 1005, 5:6–12. In addition, host data device 10 provides data to composite modem 20. *Id.* at 4:62–65. Further, in this figure, “[d]evice 20 is denoted a composite modem . . . because the communications channel is typically an analog telephone line, which requires means to convert digital data into analog format, i.e., to modulate the data on a carrier signal.” *Id.* at 4:66–5:2. Barr discloses “however, if a digital communications channel is utilized, the digital data would not require modulation and corresponding demodulation at the receiver end.” *Id.* at 5:2–5.

The data from host data device 10 is provided to switching circuitry 25. Ex. 1005, 5:6–7. “[C]omposite modem 20 also comprises a host

microprocessor 30, and read-only-memory 35 having stored therein a program which determines the transmission characteristics of the data to be transmitted over the communications channel 45, preferably randomly via a random number generator program.” *Id.* at 5:6–13. “[H]ost microprocessor 30 is coupled via a control bus 40 to switching circuitry 25.” *Id.* at 5:17–18. A “configuration message which defines the particular configuration of the transmitted message is communicated to switching circuitry 25 via control bus 40.” *Id.* at 5:17–21. “Switching circuitry 25 is coupled to a plurality of transmission/reception characteristic controllers 50, 60, 70, 80, 90, 100 and 110.” *Id.* at 5:24–26. These characteristic “controllers allow the selection of a particular variation of a characteristic, e.g., if the characteristic is the modulation technique, then FM, AM, PM or QAM modulation can be selected, for example.” *Id.* at 5:26–30. For example, “[c]haracteristic controller 110 comprises means for varying the modulation technique.” *Id.* at 8:46–47. “Suitable modulation techniques include amplitude modulation (AM), frequency modulation (FM) or frequency shift keying (FSK), phase modulation (PM) or quadrature amplitude modulation (QAM).” *Id.* at 8:51–54.

b. Hofstetter

Hofstetter discloses the optical transmitter shown in Figure 1, reproduced below:



As illustrated, the transmitter includes light source 1, optical modulator 2 and control unit 3. Ex. 1006, 3:35–39. Output 5 of optical modulator 2 provides the modulated signal to optical receiver 102 via fiber optic 101. *Id.* at 3:42–44. Control unit 3 provides a current control signal (first control signal) and a voltage control signal (second control signal) to light source 1 and optical modulator 2, respectively. *Id.* at 4:9–19.

Figure 2, reproduced below, provides a table of combinations of control signals that control unit 3 uses to produce output signals at output 5:

TABLE

FIRST CONTROL SIGNAL (A)	SECOND CONTROL SIGNAL (B)	THIRD CONTROL SIGNAL (C)	OUTPUT (5 OR 13) (D)
1. ASK	CW	-	ASK
2. DC	CW	ASK	ASK
3. DC	ASK	-	ASK
4. DC	CW	FSK	FSK
5. DC	PSK	-	PSK
6. DC	QAM	-	QAM
7. DC	CW	PSK	PSK
8. ASK	PSK	-	QAM
9. DC	ASK	PSK	QAM
10. AM	CW	-	AM
11. DC	AM	-	AM
12. DC	FM	-	FM
13. DC	PM	-	PM
14. DC	CW	AM	AM
15. DC	CW	FM	FM
16. DC	CW	PM	PM
17. AM	PM	-	AM AND PM

FIG.2

As shown, the table in Figure 2 has columns identifying a first control signal (A) for light source 1, a second control signal (B) for optical modulator 2, a third control signal (C) for optical modulator 14 in the embodiment of Figure 3, and an output (D) that results from the listed

combinations of control signals. Ex. 1006, 4:47–51. The transmitter of Figure 3 has output 13. *Id.* at 4:47–51, 5:63–6:4. “Rows 1 to 9 of the table show possible combinations to obtain light at the output 5 which is modulated with a digital intelligence signal, and rows 10 to 17 show possible combinations to obtain light at the output 5 which is modulated with an analog intelligence signal.” *Id.* at 4:51–56. And “[a]n intelligence signal can be both a data signal and a voice signal.” *Id.* at 4:56–57.

Referring to row 1 in the table of Figure 2, Hofstetter discloses that to obtain intensity-modulated light (ASK, amplitude shift keying) at “output 5 . . . the first control signal, i.e., the laser current, is a digital intelligence signal, so that light emitted by the light source 1 is modulated in intensity according to the information contained in the laser current (ASK).”

Ex. 1006, 4:58–65. Further, Hofstetter discloses that “[t]he second control signal, i.e., the control voltage, is a constant-amplitude sinusoidal signal of fixed frequency ω (cw).” *Id.* at 4:65–67. Hofstetter describes that, in row 3 of the table, the first control signal, “i.e., the laser current, is a direct current (DC) carrying no intelligence signal, so that light emitted by the light source 1 has a constant intensity and the second control signal is a digital intelligence signal which is a variable amplitude sinusoidal signal of fixed frequency (ASK).” *Id.* at 5:4–9. Hofstetter explains that “[t]his means that the second control signal (sinusoidal signal) is modulated in accordance with the digital intelligence signal to be transmitted.” *Id.* at 5:9–13.

In row 8, controller 3 controls “light source 1 by an intelligence-signal-carrying direct current and the optical modulator 2 by an intelligence-signal-carrying control voltage, so that light emerging at the output 5 is intensity modulated.” *Id.* at 5:14–18. The two intelligence

signals can be either equal or different. *Id.* at 5:18–20. With the QAM (quadrature amplitude modulation) output, one intelligence signal is represented by the intensity of the light, and the other by its phase. *Id.* at 5:20–33.

“The optical transmitter shown in [Figure] 1 can transmit both amplitude-modulated, i.e., ASK, AM, QAM, and angle modulated, i.e., FSK, FM, PSK, PM, intelligence signals.” Ex. 1006, 6:15–18.

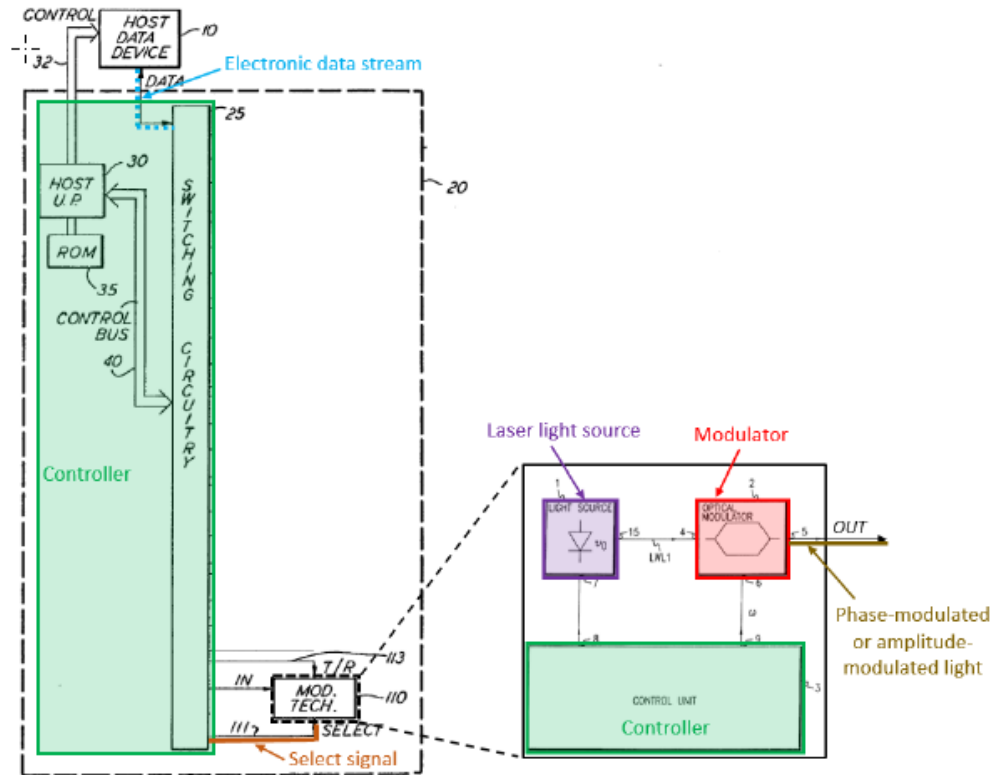
c. Proposed Combination of Barr and Hofstetter

We address Petitioner’s proposed combination of Barr and Hofstetter before addressing Petitioner’s showing regarding the claim limitations for ease of reference. The Petition addresses the proposed combination before addressing claim limitations. Pet. 17–21. Further, when addressing the claim limitations, Petitioner often compares its proposed combination with the limitation. *Id.* at 21–49. Thus, for ease in understanding the parties’ arguments, we first address Petitioner’s proposed combination of Barr and Hofstetter.

i. Petitioner’s Proposed Combination and Support for the Combination Provided with the Petition

Dr. Winters sets forth Petitioner’s proposed combination of Barr and Hofstetter. Ex. 1003 ¶ 82. Dr. Winters testifies that Barr teaches that its transmitter can be an optical transmitter. *Id.* ¶ 80. Dr. Winters further testifies that an ordinarily skilled artisan would have been motivated to integrate features of Hofstetter’s optical transmitter, including Hofstetter’s light source 1, optical modulator 2, and control unit 3 into Barr’s characteristic controller 110. *Id.* Dr. Winters testifies that this modification

would result in the First Modified Optical Module Transmitter shown in Composite Figure 1, reproduced below:



Composite Figure 1: First Modified Optical Transmitter based on Barr and Hofstetter

Id. ¶ 82. In Composite Figure 1, Dr. Winters shows Barr’s characteristic controller 110 in dashed black lines, Hofstetter’s light source 1 in purple, Hofstetter’s optical modulator 2 in red, and Barr’s microprocessor 30, memory 35, and switching circuitry 25 together with Hofstetter’s control unit 3 in green. *Id.* ¶ 83. Dr. Winters refers to microprocessor 30, memory 35, switching circuitry 25, and control unit 3 as a composite controller. *Id.* Dr. Winters omits characteristic controllers 50–100 from the Composite Figure, focusing on the variation of modulation technique for simplicity. *Id.* ¶ 84. Dr. Winters explains that the data to be transmitted by the First

Modified Optical Transmitter would be received by switching circuitry 25 and could be an electronic signal, as described by Barr. *Id.* ¶ 85 (citing Ex. 1005, 5:6–7, 6:41–42).

Dr. Winters further testifies that this stream of data to be transmitted would then be input to the modified characteristic controller 110 via the “IN” line, such that the output light from the optical modulator 2 would be phase-modulated or amplitude modulated as a function of the stream of data to be transmitted. Ex. 1003 ¶ 85 (citing Ex. 1005, 2:3–14, 2:22–28, 5:41–45, 6:41–42, 13:10–13; Ex. 1006, 2:46–48, 4:51–57). Dr. Winters further testifies that the composite controller in the First Modified Optical Transmitter would be able to operate in the phase modulation and amplitude modulation modes specified in Figure 2 of Hofstetter. *Id.* ¶ 87. Dr. Winters further testifies that the phase and amplitude modulation modes would occur at different times as described by Barr. *Id.* ¶ 89.

Dr. Winters testifies that an ordinarily skilled artisan would have been motivated to make the First Modified Optical Transmitter because Barr suggests using its transmitter as an optical transmitter, which would motivate an ordinarily skilled artisan to add Hofstetter’s light source 1 and optical modulator 2 into Barr’s characteristic controller 110. Ex. 1003 ¶ 92. Dr. Winters also testifies that an ordinarily skilled artisan would position Hofstetter’s laser 1 directly adjacent to the optical modulator 2, as is the configuration in Hofstetter’s unmodified optical transmitter, to achieve size efficiency and a reduction in complexity of the configuration of the optical transmitter. *Id.* Dr. Winters further testifies that an ordinarily skilled artisan would have been motivated to incorporate Hofstetter’s control unit 3 into Barr’s characteristic controller 110 to form part of the composite

control to provide a way to control the operation of laser 1 and optical modulator 2. *Id.*

Dr. Winters further testifies that an ordinarily skilled artisan would have been motivated to modify Barr's transmitter to have optical communications functionality given Barr's disclosure of the high bandwidths available for optical transmissions. Ex. 1003 ¶ 93. Dr. Winters further testifies that in creating such an optical transmitter an ordinarily skilled artisan would have been motivated to retain the functionality taught by Barr of switching between modulation techniques. *Id.* ¶¶ 93–94.

Further, Dr. Winters testifies that an ordinarily skilled artisan would have had a reasonable expectation of success in combining Barr and Hofstetter to arrive at the First Modified Optical Transmitter for three reasons. Ex. 1003 ¶ 95. First, Dr. Winters testifies that Barr's transmitter is already compatible with optical communications and a variety of carrier media. *Id.* Second, Dr. Winters testifies that Barr's characteristic controller 110 and switching circuitry 25 are generic, which would give an ordinarily skilled artisan confidence that they would be compatible with their use in the First Modified Optical Transmitter. *Id.* Third, Dr. Winters testifies that Barr's disclosure of modulation techniques is generic and Hofstetter discloses amplitude and phase modulation. *Id.*

ii. Patent Owner's Response

Patent Owner disputes that an ordinarily skilled artisan would have combined Barr and Hofstetter to produce the First Modified Optical Transmitter. PO Resp. 27–38. To support this position, Patent Owner cites documentary exhibits, but no expert testimony. *Id.*

Patent Owner argues that Barr repeatedly discloses that its invention is to provide secure electronic communications. PO Resp. 30. Patent Owner further argues that to provide secure electronic communications, Barr discloses that its composite modem 20 uses a variety of controllers. *Id.* at 31. Further, Patent Owner asserts that composite modem 20 transmits both a configuration message and data to a receiving unit. *Id.* at 32. According to Patent Owner, Barr teaches that variable characteristics and the transmission of a configuration message are critical. *Id.*

As a result, Patent Owner argues that an ordinarily skilled artisan would not have been motivated to produce the First Modified Optical Transmitter. PO Resp. 34–38. Patent Owner asserts that Petitioner has not addressed how the First Modified Optical Transmitter would inform the receiver of the switching circuit's configurations. *Id.* at 35. Patent Owner also argues that Petitioner omitted characteristic controllers 50, 60, 70, 80, 90, and 100 from composite modem 20 to form the First Modified Optical Transmitter, and an ordinarily skilled artisan would not want to do that. *Id.* at 35–36.

Patent Owner further asserts that, because the First Modified Optical Transmitter does not send a configuration message, its corresponding receiver must perform additional work to determine the configuration, which Barr teaches is undesirable. *Id.* at 36. Patent Owner also argues by including only modulation controller 110, Petitioner has made the First Modified Optical Transmitter less secure, which is undesirable. *Id.* at 36–37.

iii. Petitioner's Reply

With its Reply, Petitioner does not provide any further expert testimony regarding its proposed combination of Barr and Hofstetter. Pet. Reply 14–15. Petitioner, however, responds to Patent Owner's arguments regarding the formation of Petitioner's First Modified Optical Transmitter. *Id.* Petitioner asserts that Dr. Winters showed only one controller in its Composite Figure 1 for simplicity, not because the First Modified Optical Transmitter would have only one controller. *Id.* at 14. Petitioner further argues that Barr teaches that the number of components is dictated by market requirements for degree of security and cost and that fewer controllers will be required for lower security requirements. *Id.* at 15. According to Petitioner, therefore, even one controller would be consistent with Barr's disclosure. *Id.*

Petitioner also asserts that, although Patent Owner argues that converting modulation controller into an output channel prevents Barr's sending of the configuration message from an output of switching circuit 25, Barr suggests using its composite modem for optical transmissions. Pet. Reply 15.

iv. Patent Owner's Sur-reply

Patent Owner's Sur-reply does not address the reasons Petitioner offered for combining Barr and Hofstetter. PO Sur-reply 1–16.

v. Analysis

We determine that Petitioner has proven that an ordinarily skilled artisan would have been motivated to combine Barr's and Hofstetter's teachings to produce the First Modified Optical Transmitter shown in

Composite Figure 1 and that an ordinarily skilled artisan would have had a reasonable expectation of success in doing so.

First, we credit the testimony of Dr. Winters that an ordinarily skilled artisan would have combined Barr's and Hofstetter to produce the First Modified Optical Transmitter and would have had a reasonable expectation of success in doing so. Ex. 1003 ¶¶ 80–95. As mentioned, Mr. McAlexander provides no contrary testimony. PO Resp. 27–38; Ex. 2005 ¶¶ 28–60.

Second, as Dr. Winters testifies, Barr teaches that its transmitter can be an optical transmitter. Ex. 1003 ¶ 92. Barr states that “[t]he present invention also has application to communications channels wherein fiber optic links provide the transmission medium.” Ex. 1005, 1:28–32. Further, Barr teaches the advantages of using an optical transmitter in its composite modem, disclosing that “[m]uch wider bandwidths are available for . . . fiber optic transmissions, and thus much higher transmission speeds are possible.” *Id.* at 5:62–65. As a result, we credit Dr. Winters' testimony that an ordinarily skilled artisan would have been motivated to integrate features of Hofstetter's optical transmitter, including Hofstetter's light source 1, optical modulator 2, and control unit 3 into Barr's characteristic controller 110. Ex. 1003 ¶ 92. Further, as Dr. Winters testifies, Hofstetter discloses a laser as light source 1. *Id.* ¶ 67; Ex. 1006, 3:52–62.

Third, we credit Dr. Winter's testimony that an ordinarily skilled artisan would position Hofstetter's light source directly adjacent to the optical modulator 2, as is the configuration in Hofstetter's unmodified optical transmitter, to achieve size efficiency and a reduction in complexity of the configuration of the optical transmitter. Ex. 1003 ¶ 92. We further

credit Dr. Winters's testimony that an ordinarily skilled artisan would have been motivated to incorporate Hofstetter's control unit 3 into Barr's characteristic controller 110 to form part of the composite control to provide a way to control the operation of the light source 1 and optical modulator 2. *Id.*

Fourth, we credit Dr. Winter's testimony that, in creating such an optical transmitter, an ordinarily skilled artisan would have been motivated to retain the functionality taught by Barr of switching between modulation techniques. Ex. 1003 ¶ 93. Barr teaches the importance of having that functionality for its composite modem. Ex. 1005, 1:55–56 (“insur[ing] the integrity of the data transmission by varying the characteristics of the signal.”), 1:62–66 (“At intervals, for example, at random intervals, the transmission protocol is changed, thereby preventing an unauthorized person from intercepting the data transmitted over the communications channel in an informative way.”), 4:33–36 (“The probability of unauthorized interception is inversely proportional to ... the rapidity with which the configurations are changed.”).

Fifth, we credit Dr. Winter's testimony that an ordinarily skilled artisan would have been motivated to include Barr's switching circuitry in the First Modified Optical Transmitter to retain a way to switch between modulation techniques. Ex. 1003 ¶ 94. Barr teaches the desirability of switching modulation techniques for security purposes. Ex. 1005, 1:62–65 (“At intervals, for example, at random intervals, the transmission protocol is changed, thereby preventing an unauthorized person from intercepting the data transmitted over the communications channel in an informative way, since the intercepting party would have to be able to change the

characteristics of the receiver to match the transmitter.”), 2:3–14, 3:53–59, 5:4–45, 8:52–58, 12:55–58, 13:5–7.

Sixth, we credit Dr. Winters’s testimony that an ordinarily skilled artisan would have had a reasonable expectation of success in combining Barr and Hofstetter to arrive at the First Modified Optical Transmitter. Ex. 1003 ¶ 95. Barr teaches that its transmitter is compatible with optical communications: “The present invention also has application to communications channels wherein fiber optic links provide the transmission medium.” Ex. 1005, 1:28–32. Barr further teaches that its transmitter can be used with a variety of carrier media: “the system of the present invention can be adjusted to meet the requirements of substantially all carrier media.” *Id.* at 2:22–25. Further, as Dr. Winters testifies, Barr teaches that its controller 110 and switching circuitry 25 are generic. Ex. 1003 ¶ 95. Barr states: “Although details of the switching circuitry 25 and the various characteristic controllers [50–110] are not shown, it will be readily apparent to a person of skill in the art how such circuitry for accomplishing the indicated functions can be provided.” Ex. 1005, 8:66–9:3. We credit Dr. Winters’ testimony that this disclosure indicates that these elements of Barr’s transmitter would be compatible with the modifications set forth for the First Modified Optical Transmitter. Ex. 1003 ¶ 95. We further credit Dr. Winters’ testimony that Barr’s disclosure of modulation techniques is generic, which indicates that Barr’s disclosure of switching between amplitude and phase modulated techniques would be compatible with Hofstetter’s disclosure of amplitude modulation (such as ASK and QAM) and phase modulation (such as PSK) for transmission of digital intelligence

signals. *Id.*; Ex. 1005, 1:57–63, 5:6, 6:41–42; Ex. 1006, 2:46–48, 4:47–51, 4:58–5:12, 5:24–26, 5:34–36, 6:48–57, Fig. 2.

Further, we do not agree with Patent Owner’s counterarguments. As discussed in Section II.C.2.c.ii., Patent Owner argues that an ordinarily skilled artisan would find the First Modified Transmitter undesirable because it omits characteristic controllers 50–100. PO Resp. 36–38. Nothing about the First Modified Optical Transmitter, however, requires that characteristic controllers 50–110 be omitted. Dr. Winters testifies that he did not illustrate controllers 50–100 in Composite Figure 1 to simplify the figure and more easily illustrate the proposed variation of the modulation technique. Ex. 1003 ¶ 84. Further, Barr teaches the components (e.g., characteristic controllers) to be used in its composite modem depends on the application:

If the requirement for security is very high, the number of components will be increased to the level where the number of possible transmission configurations will be of such sufficient magnitude to make the probability of interception extremely low. The resulting cost of the device will, accordingly, be high. If, on the other hand, security requirements are lower, fewer components will be required and the number of possible configurations will be lower. The cost will be less but the probability of possible interception will increase.

Ex. 1005, 2:34–45. The First Modified Optical Transmitter has the same tradeoffs and options. Ex. 1003 ¶ 84.

Patent Owner further argues that the First Modified Optical Transmitter with its optical communications would not be able to send a configuration message from switching circuit 25 and that lack of ability to

send a configuration message would discourage an ordinarily skilled artisan from making the First Modified Optical Transmitter. PO Resp. 36. Patent Owner, however, provides no support for this argument. *Id.* The First Modified Optical Transmitter communicates with its receivers optically. Ex. 1003 ¶ 93. Patent Owner has given no reason why a configuration message could not be sent via fiber optic communication, particularly when Barr, which discloses the use of a configuration message, teaches the use of fiber optic communications. PO Resp. 36; Ex. 1005, 1:28–32, 5:62–64. In light of this disclosure in Barr, we find that configuration messages would not discourage an ordinarily skilled artisan from modifying Barr to support optical communications.

In sum, Petitioner has proven that an ordinarily skilled artisan would have combined Barr and Hofstetter to produce the First Modified Optical Transmitter and that an ordinarily skilled artisan would have had a reasonable expectation of success in producing that transmitter.

d. Limitations of Independent Claim 1

i. An optical data transmitter

Petitioner argues that Hofstetter teaches an optical data transmitter by disclosing: “a communications system comprising an optical transmitter.” Pet. 22 (quoting Ex. 1006, 1:6–9). Further, Petitioner argues that Barr discloses a transmitter, quoting Barr’s disclosures of “an apparatus for providing secure electronic communications over a communications medium” (Ex. 1005, Abstract) and “[t]he present invention controls transmission between first and second data devices” (*id.* at 1:52–53). Pet. 21–22. Petitioner further asserts that Barr discloses that its transmitter can be an optical data transmitter by describing: “[t]he present invention

also has application to communications channels wherein fiber optic links provide the transmission medium.” *Id.* at 22 (quoting Ex. 1005, 1:28–32) (emphasis omitted). Further, Petitioner asserts that an ordinarily skilled artisan implementing Barr’s transmitter in an optical context would have drawn from features of Hofstetter’s optical transmitter to create the First Modified Optical Transmitter, described above. *Id.* Petitioner’s arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 52–53, 67, 80–95.

Patent Owner does not dispute that Hofstetter teaches an optical data transmitter or that the First Modified Optical Transmitter has an optical data transmitter. After reviewing the record, we find that Petitioner has proven that Hofstetter teaches an optical data transmitter and that the First Modified Optical Transmitter would have an optical data transmitter.⁸

ii. a laser

Petitioner argues that Hofstetter teaches an optical transmitter with a laser, quoting Hofstetter’s disclosures of: (i) “an optical transmitter comprising a light source 1,” and (ii) “light source 1 will generally be a laser module containing, for example, a DFB laser . . . [or] a BH laser.” Pet. 22 (quoting Ex. 1006, 3:36–37, citing Ex. 1006, 3:52–62). Petitioner further argues that when implementing Barr’s transmitter for optical communications, an ordinarily skilled artisan would have incorporated Hofstetter’s laser into Barr’s transmitter as shown with the First Modified Optical Transmitter shown in Composite Figure 1. *Id.* at 22–23.

⁸ In light of this finding, we do not need to determine whether the preamble recitation of “[a]n optical data transmitter” is a claim limitation.

Petitioner's arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 67, 80–81, 92–93. Patent Owner does not dispute that Hofstetter discloses a laser or that the First Modified Optical Transmitter has a laser. After reviewing the record, we determine that Petitioner has proven that Hofstetter teaches a laser and that the First Modified Optical Transmitter would have a laser.

iii. a phase modulator for phase modulating light from the light source

The parties dispute whether the combination of Barr and Hofstetter teaches the recited phase modulator. Pet. 23–26; PO Resp. 7–27.

(a) The Parties' Arguments and Expert Testimony

(i) Petition and Winters Declaration

In the Petition, Petitioner argues that Hofstetter's optical modulator 2 modulates light from a light source, quoting Hofstetter's disclosure of: "light emitted by the light source 1 enters the optical modulator 2." Pet. 23 (quoting Ex. 1006, 3:39–42). Further, Petitioner argues that row 5 in Hofstetter Figure 2 specifies phase modulation. *Id.* Petitioner further asserts that characteristic controller 110 in Barr is a modulator for phase modulating signals. *Id.* In addition, Petitioner argues that when an ordinarily skilled artisan would have configured Barr's transmitter for optical communications, that artisan would have included a phase modulator like Hofstetter's optical modulator 2 in the First Modified Optical Transmitter. *Id.* at 24.

Petitioner cites the testimony of Dr. Winters to support these arguments. Pet. 23–24 (citing Ex. 1003 ¶¶ 73, 75, 80–82). Dr. Winters testifies that Hofstetter discloses that its optical modulator 2 can be a Mach-

Zehnder modulator or any of a variety of other modulators. Ex. 1003 ¶ 67. Dr. Winters further testifies that Hofstetter discloses that its optical transmitter can transmit both amplitude and angle modulated intelligence signals and that angle modulated signals include PSK modulation, which is a phase modulation technique. *Id.* ¶ 68. Further, Dr. Winters testifies that Figure 2 of Hofstetter depicts combinations of first and second control signals (columns A and B) that are provided to the light source and optical modulator, respectively, and the modulation format of the resulting output signal (column D). *Id.* ¶ 70.

Dr. Winters further testifies that Row 1 of Figure 2 shows a combination of control signals that produces amplitude modulated output light, specifically amplitude-shift keyed light. Ex. 1003 ¶ 71. Dr. Winters further testifies Row 5 of Hofstetter's Figure 2 shows a combination of control signals that produces phase-modulated output light, specifically phase-shift keyed light. *Id.* ¶ 73. Dr. Winters quotes the following disclosure from Hofstetter to support that testimony: "the control unit (3) controls the light source (1) with a direct current carrying no intelligence signal, so that light emitted by the light source (1) has a constant intensity, and that the control unit (3) controls the optical modulator (2) with a constant-amplitude and variable frequency control voltage carrying the intelligence signal, so that light emerging at the output (5) of the optical modulator (2) is angle-modulated." *Id.* (quoting Ex. 1006, 7:8–16, which is claim 4 of Hofstetter). Dr. Winters further testifies that "the combination of control signals shown in Row 5 produces output light that is phase-modulated but not amplitude modulated." *Id.* ¶ 74.

Further, Dr. Winters testifies that row 13 of Hofstetter's Figure 2 shows a combination of control signals that outputs phase-modulated light. Ex. 1003 ¶ 74. Patent Owner notes that, during redirect-examination, Dr. Winters addressed the disclosure in Hofstetter that refers to Walker (Ex. 1023) and states "optical modulator 2 can also be any of the other modulators mentioned therein." PO Resp. 22 (citing Ex. 2004, 176:6–17, 4:3–4). In the cited testimony, Dr. Winters testified that, in addressing Walker, Hofstetter discloses the Mach-Zehnder modulator is not the only type of modulator that can be used as optical modulator 2. Ex. 2004, 176:6–17. Patent Owner's arguments regarding this testimony are addressed in the next section.

(ii) Patent Owner Response and M^cAlexander Declaration

In the Patent Owner Response, Patent Owner argues that Hofstetter discloses that the optical transmitter of its Figure 1 is formed of the optical modulator of Figure 2 of R2005 (Ex. 2001). PO Resp. 8–9. Patent Owner further asserts that R2005's optical modulator only produces amplitude modulation of light. *Id.* at 9–10. Further, Patent Owner asserts that, although Hofstetter discloses phase modulated *intelligence signals*, Hofstetter's intelligence signals affect *how* output 5's light is amplitude modulated, but not its modulation *type*, which is always amplitude modulation. *Id.* at 12–13. Patent Owner further argues that Figure 2 of Hofstetter does not disclose modulation formats of optical signals. *Id.* at 14, 17. Further, Patent Owner asserts that the Hofstetter's references to phase modulation refers to only phase modulation of electrical intelligence signals or control signals, not optical modulation. *Id.* at 15–17.

Patent Owner further argues that Hofstetter does not disclose any consideration of an optical signal's phase to decode transmitted data. PO Resp. 18. Patent Owner also asserts that Hofstetter discloses an identical signal structure as R2005. *Id.* at 19. Further, Patent Owner argues that Dr. Winters failed to consider the teachings of R2005. *Id.* at 22–27. Patent Owner also argues that the title of Walker indicates that it is directed to intensity modulators. *Id.* at 23. Patent Owner further asserts that Dr. Winters did not consider Walker when he prepared his declaration. *Id.* Patent Owner also cites Dr. Winter's testimony regarding Walker that: "I can't recall exactly which types of modulators were disclosed in that paper." *Id.* (quoting Ex. 2004, 178:9–14).

Patent Owner cites the testimony of Mr. McAlexander to support these arguments. PO Resp. 8–27 (citing Ex. 2005 ¶¶ 28–58).

Mr. McAlexander testifies that Hofstetter disclose[s] only optical amplitude modulation and fails to disclose or suggest 'a phase modulator for phase modulating light from a light source.'" Ex. 2005 ¶ 28. Mr. McAlexander interprets Hofstetter as confirming that the optical transmitter of Figure 1 of Hofstetter is formed of the optical modulator of R2005's Figure 2. *Id.* ¶¶ 29–31. Mr. McAlexander further testifies that "[i]t is a mathematical certainty that Hofstetter does not transmit and does not disclose, any phase-modulated optical signal." *Id.* ¶ 33. Mr. McAlexander further testifies that, in Hofstetter, the drive voltage's amplitude and the drive frequency are encoded only into the amplitude, not the phase, of the optical signal. *Id.* Further, Mr. McAlexander testifies that R2005 supports this opinion. *Id.* Mr. McAlexander further testifies that "because R2005 and Hofstetter's optical signal output from the modulator lacks any phase-

shift component, and because the amplitude, not the phase, of the optical signal is modified by α , the normalized amplitude of the drive voltage, the output from the modulator is an amplitude-modulated optical signal, not a phase-modulated optical signal.” *Id.* ¶ 37.

Mr. McAlexander addresses Dr. Winter’s testimony that Table 2 of Hofstetter discloses phase modulation of light. Ex. 2005 ¶ 42. Mr. McAlexander notes Dr. Winter’s reliance on the disclosure in column 7, lines 8–16 (claim 4) of Hofstetter. *Id.* Mr. McAlexander testifies that Figure 2 of Hofstetter, however, does not disclosure modulation formats of optical signals. *Id.* ¶ 43. Mr. McAlexander further testifies that Figure 2 of Hofstetter uses the term “output signal” to refer to the signal that is modulated or encoded onto the optical carrier. *Id.*

Mr. McAlexander testifies that the outputs listed in Figure 2 of Hofstetter could be modulated onto an optical signal using amplitude modulation. Ex. 2005 ¶ 44. Mr. McAlexander further testifies that Hofstetter’s disclosure of the modulation format of intelligence signals does not equate to the modulation format of the optical signal. *Id.* ¶ 48. Mr. McAlexander further testifies that Hofstetter’s use of a photodetector to receive and decode the intelligence signals indicates that Hofstetter only discloses optical amplitude modulation. *Id.* ¶ 49. Mr. McAlexander also testifies that Hofstetter’s “identical signal structure as R2005 confirms nearly equivalent operation of the optical modulator in the two references.” *Id.* ¶ 51. Mr. McAlexander also testifies that a QAM-modulated signal processes an I component and a Q component. *Id.* ¶ 59. Mr. McAlexander further testifies that a conventional way of producing a QAM modulated signal is to provide two MZMs (Mach-Zehnder modulators) each with their

own control voltages and that Hofstetter does not disclose or suggest this. *Id.* Mr. McAlexander further testifies that Dr. Winters does not explain how an MZM can produce a QAM modulated optical signal based on a QAM modulated sinusoidal electrical signal and bias inputs. *Id.* ¶ 60.

(iii) Reply

In its Reply, Petitioner argues that Hofstetter expressly discloses that its transmitted intelligence signals can be represented by the light's phase. Pet. Reply 2 (citing or quoting Ex. 1006, 2:32–35, 4:60–65, 5:21–22, 5:25–26). Petitioner argues that Hofstetter discloses that light emerging at the output of the optical modulator is angle modulated. *Id.* at 3 (quoting Ex. 1006, 7:12–16). Petitioner further argues that Hofstetter teaches that Figure 2 shows how the light emerging at output 5 is modulated. *Id.* at 4 (quoting Ex. 1006, 4:6–7). Petitioner further argues that Mr. McAlexander explains that Hofstetter's identifying output 5 in row 5 of Hofstetter Figure 2 is because "Hofstetter is screwed up when he tries to explain this." *Id.* at 4–5 (citing Ex. 1022, 26:15–16). Petitioner also argues that Hofstetter distinguishes its optical modulator from R2005's. *Id.* at 6–7.

Petitioner further asserts that Hofstetter discloses that its optical modulator is not limited to being a Mach-Zehnder modulator. *Id.* at 11–13. Petitioner further argues that Walker discloses vertical p-i-n-type phase modulators, a GaAs p-i-n TW Phase Modulator, and GaAs-AlGaAs phase modulators. *Id.* at 13 (citing Ex. 1023, 1–5). Petitioner also argues that Hofstetter discloses that two intelligence signals can be recovered with a suitable demodulator. *Id.* at 14 (quoting Ex. 1006, 5:20–24).

Petitioner does not submit any further testimony from Dr. Winters to support these arguments.

(iv) Sur-reply

In its Sur-reply, Patent Owner responds that Petitioner has not disputed that R2005 discloses only amplitude modulated light. PO Sur-reply 2. Patent Owner also argues that Petitioner focuses on what Hofstetter does not preclude, rather than what it discloses. *Id.* at 3. Patent Owner further asserts that the different modulation formats referred to in Hofstetter refer to modulation in the electrical domain, not in the optical domain. *Id.* at 4. Further, Patent Owner asserts that Petitioner does not dispute the similarities in the transmitted signals in both Hofstetter and R2005. *Id.* at 6. Patent Owner also argues that Hofstetter does not disclose a receiver configuration for decoding any light, other than amplitude modulated light. *Id.* at 7–8. Patent Owner also argues that Petitioner’s reliance on the Walker reference was belated and lacks supporting expert testimony. *Id.* at 9–10. Patent Owner also argues that Petitioner’s arguments regarding claim 4 of Hofstetter are contradicted by R2005. *Id.* at 13.

(b) Analysis

We find that Hofstetter teaches phase modulating light. First, on its face, Figure 2 of Hofstetter teaches phase modulating light (e.g., PSK and PM light). Both experts agree that Hofstetter’s output 5 emits light. Ex. 1003 ¶ 70 (“[t]he output signal is light . . .”); Ex. 2005 ¶ 45 (“light at the output 5 . . .”); *see also* Ex. 1006, code (57) (“light emerging at the output (5) of the modulator (2)”), 4:51–55 (“light at the output 5”), 7:15–16 (“light emerging at the output (5)”). On its face, Figure 2 teaches that output 5 in row 5 is “PSK,” which is phase shift key modulated, a form of phase modulation. Ex. 1003 ¶ 61 (“PSK is an example of a phase modulation

technique.”). On its face, the table in Figure 2 further teaches the output 5 in row 13 is “PM,” which is phase modulation. Ex. 1006, Fig. 2; Ex. 1003 ¶ 61 (“phase modulation (PM)”) (quoting Ex. 1005, 5:27–30). Mr. M^cAlexander does not dispute that the designations PSK and PM refer to phase modulation techniques, but, as discussed above, disputes that the modulation technique listed for output 5 is for light. Ex. 2005 ¶ 43.

Second, Dr. Winters testifies that an ordinarily skilled artisan would have recognized the modulation formats specified in rows 5 and 13 of Figure 2 as the modulation formats for the light emitted by output 5. Ex. 1003 ¶ 73. Mr. M^cAlexander disagrees, testifying that the light emitted by output 5 is always amplitude modulated and the specified modulation for output 5 in Figure 2 is merely that for an electronic signal used to produce the amplitude modulated light at output 5. Ex. 2005 ¶ 43. We credit Dr. Winter’s testimony on this issue and find that the modulation specified for output 5 on rows 5 and 13 of Figure 2 of Hofstetter is the modulation type of output 5’s emitted light. Ex. 1003 ¶ 73. In other words, Figure 2 specifies what it appears to teach: the modulation format of the light emitted by output 5, which, for rows 5 and 13, are types of phase modulation.

The record supports Dr. Winter’s testimony on this issue. Hofstetter teaches: “*the light emerging at output (5) of the optical modulator (2) is angle modulated.*” Ex. 1006, 7:14–16 (emphasis added). The fact that output 5 produces angle-modulated light is consistent with Dr. Winter’s testimony that output 5 emits phase modulated light: “[p]hase modulation is a type of angle modulation.” Ex. 1003 ¶ 73; *see also* Ex. 1006, 5:34–36 (“angle modulated, i.e., FSK, FM, *PSK*, *PM*”) (emphasis added); 5:30–31 (“*PSK*, phase-shift keying”); Ex. 1003 ¶ 68 (“*PSK* is an example of a phase

modulation technique.”), ¶ 73 (identifying the “PM” output in row 13 of Figure 2 of Hofstetter as phase modulation.).

The fact that output 5 emits angle-modulated light, however, is not consistent with Mr. McAlexander’s testimony. As mentioned, Mr. McAlexander testifies that output 5 only emits amplitude modulated light. Ex. 2005 ¶ 41. Hofstetter distinguishes angle modulation from amplitude modulation. Ex. 1006, 5:34–36; 6:35–37. Further, Mr. McAlexander had the opportunity to explain how his testimony could be consistent with Hofstetter’s disclosure of angle modulated light, but did not. Ex. 2005 ¶ 42. Mr. McAlexander cites that disclosure in his declaration, but does not explain how his testimony is consistent with it. *Id.* Patent Owner address this issue in its Sur-reply, asserting that R2005 contradicts the disclosure at issue. Sur-reply 13. We disagree. Hofstetter expressly states “*the light emerging at output (5) of the optical modulator (2) is angle modulated.*” R2005, which was published before Hofstetter was filed, does not address that disclosure. Ex. 2001 (published December 1993); Ex. 1006, code (30) (“December 13, 1994”).

Third, we do not credit Mr. McAlexander’s testimony that optical modulator 2 in Hofstetter is only the optical modulator described in R2005, which only produces amplitude modulated light. Ex. 2005 ¶ 41. Mr. McAlexander cites the following passage in Hofstetter to support that testimony:

A communication system and an optical transmitter with the features recited in the preamble are known from J. J. O'Reilly, "RACE R2005: microwave optical duplex antenna link", IEE Proceedings-J, Vol. 140, No. 6, December 1993, pages 385-391.

The optical transmitter shown in FIG. 2 of that article forms part of an optical communication system illustrated in FIG. 1, wherein besides an optical receiver including an optical-to-electrical transducer, an antenna is provided at the receiving end.

Ex. 1006, 1:19–27 (quoted in part by Ex. 2005 ¶ 29). This passage, however, merely describes that *a* communication system and *an* optical transmitter with the features recited in the preamble are known from R2005, not that R2005 discloses the only communication systems and optical transmitters with those features.

Further, we do not agree that the second sentence of the quoted passage above refers to the optical communication system of Figure 1 of Hofstetter. Ex. 2005 ¶ 30. Instead, we find that sentence describes the optical communication system of Figure 1 of R2005. The quoted sentence is in Hofstetter’s Background of the Invention, where Hofstetter describes the prior art to its claimed invention (e.g., R2005). Ex. 1006, 1:19–2:21. The sections of Hofstetter where Hofstetter describes its own Figure 1 are titled Brief Description of the Drawing and Best Mode for Carrying Out the Invention, not the Background of the Invention. *Id.* at 3:26–27, 3:35–46. Further, the next sentence in Hofstetter indicates that the description above refers to Figure 1 of R2005, not of Hofstetter. That sentence continues describing the communication system of Figure 1, stating: “Between this antenna and a remote radio station (transposer), radio signals with a frequency of, e.g., 60 GHz are transmitted; the wavelength of these radio signals thus lies in the range of a few millimeters.” *Id.* at 1:27–30. Figure 1 of Hofstetter does not illustrate any transposer, whereas Figure 1 of R2005 does. Ex. 1006, Fig. 1; Ex. 2002, 2. We find that the Figure 1 referenced in

Hofstetter's Background of the Invention is Figure 1 of R2005, not Figure 1 of Hofstetter.

Fourth, we do not credit Mr. McAlexander's testimony that Hofstetter describes the Mach-Zehnder optical modulator as the only modulator that can be used as optical modulator 2. Ex. 2005 ¶¶ 31–32. Hofstetter discloses: “[t]he optical modulator 2 is, *for example*, a Mach-Zehnder optical modulator.” Ex. 1006, 3:66–67 (emphasis added). Hofstetter also discloses that “optical modulator 2 can be any of the other modulators mentioned [in Walker (Ex. 1023)].” *Id.* at 4:3–4. Walker refers to phase modulators and phase modulation. Ex. 1023, 1 (“vertical p-i-n phase modulators”), 2 (GaAs p-i-n TW Phase Modulator”), 3 (“phase modulation”), 4 (“phase modulation”).

Fifth, Patent Owner argues that the disclosures of phase modulators in Walker should not be considered because Petitioner did not timely address those modulators and did not provide expert testimony addressing those disclosures. Sur-reply 9–10. We disagree. The Patent Owner Response put the modulators disclosed in Walker at issue by arguing that optical modulator 2 in Hofstetter could only produce amplitude modulated light. PO Resp. 11, 15, 18. Hofstetter expressly teaches that “[t]he optical modulator 2 can also be any of the other modulators mentioned [in Walker].” Ex. 1006, 4:3–4. Thus, Patent Owner's argument in its Response put the modulators mentioned in Walker at issue, which Petitioner properly addressed in reply. PO Resp. 11, 15, 18; Pet. Reply 12–13. As for expert testimony, it may have been preferable for the parties to have submitted expert testimony on this issue. We do not agree, however, that Petitioner had to provide additional testimony from Dr. Winters to

challenge Mr. M^cAlexander's testimony that Hofstetter's optical modulators were limited to amplitude modulation. Mr. M^cAlexander testified that optical modulator 2 could only emit amplitude modulated light without addressing Hofstetter's disclosure that optical modulator 2 could be one of the modulators disclosed in Walker. Ex. 2005 ¶ 43; Ex. 1006, 4:3–4. The fact that Walker expressly discloses phase modulators undermines that testimony. Ex. 2005 ¶ 34; Ex. 1023, 1–4.

Sixth, Mr. M^cAlexander testifies that he is not aware of any Mach-Zehnder modulator that could produce a QAM modulated signal based on QAM-modulated sinusoidal electrical signal and bias inputs. Ex. 2005 ¶ 60. We do not accord much weight to this testimony. As discussed above, Hofstetter's optical modulator 2 is not limited to Mach-Zehnder modulators. Further, although Dr. Winters testified that higher orders of QAM modulated signals are both amplitude and phase modulated, we need not determine whether to credit that testimony in light of Hofstetter's non-QAM disclosures of phase modulated light (e.g., PSK and PM). Ex. 1003 ¶ 78.

In sum, we credit Dr. Winter's testimony and find that Petitioner has proven that Hofstetter teaches a phase modulator for phase modulating light from the light source and that the First Modified Optical Transmitter would have such a phase modulator. Ex. 1003 ¶¶ 92–93, 95.

iv. a controller having an input for receiving an electronic data stream

Petitioner argues that (i) the combination of Barr's switching circuitry 25, host microprocessor 30, and ROM 35 and (ii) Hofstetter's control unit 3 each constitute a controller with the recited input. Pet. 26–27,

30. Petitioner quotes Barr's disclosure that "data from data device 10 is input to switching circuitry 25." *Id.* at 28 (quoting Ex. 1005, 6:41–42). Petitioner also quotes Hofstetter's disclosures that "the light source 1 and the optical modulator are controlled by the control unit 3 to modulate the light emerging at the output 5 of the modulator" and that control unit 3 "provides a first control signal for the light source 1 and a second control signal for the optical modulator 2." *Id.* at 30 (quoting Ex. 1006, 4:5–11, 4:47–56). Petitioner further argues that the First Modified Optical Transmitter would include a composite controller that would incorporate elements of Barr's and Hofstetter's controllers. *Id.* at 33. In particular, Petitioner asserts that this composite controller would determine, and control, modulation and switching as taught by Barr and control the phase modulator as taught by Hofstetter. *Id.* Petitioner's arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 57–59, 61.

Patent Owner does not dispute that Barr and Hofstetter both teach a "controller having an input for receiving an electronic data stream" or that the First Modified Optical Transmitter would have such a controller. After reviewing the record, we determine that Petitioner has proven that Barr and Hofstetter both teach a "controller having an input for receiving an electronic data stream" and teach or suggest including such a controller in the First Modified Optical Transmitter.

v. the controller in a first mode controlling the phase modulator so as to create phase-modulated optical signals in the light from the laser as a function of the electronic data stream

Petitioner argues that Barr's microprocessor 30 has a mode that controls a phase modulator to create phase-modulated signals as a function

of an electronic data stream. Pet. 28. Petitioner further argues that Hofstetter's control unit 3 has a mode that controls a phase modulator to create phase modulated optical signals in the light from a laser as a function of the electronic data stream. *Id.* at 31. Further, Petitioner asserts that the First Modified Optical Transmitter would incorporate Barr's microprocessor 30 and Hofstetter's control unit 3. *Id.* at 33.

Regarding Barr, Petitioner argues that microprocessor 30 determines which modulation technique should be used and, when it chooses phase modulation, switching circuitry 25 sends a signal that causes characteristic controller 110 to produce phase-modulated output signals. Pet. 28–29 (citing Ex. 1005, 2:3–14, 2:25–28, 4:62–65, 5:6–45, 8:46–54). Petitioner asserts that characteristic controller 110 in Barr creates phase-modulated signals based at least in part on an electronic data stream input to the switching circuit, indicated as “DATA” in Barr Figure 1. *Id.* at 30 (citing Ex. 1005, 2:3–14, 2:22–28, 5:41–45, 13:10–13; Ex. 1003 ¶ 60). Further, Petitioner argues that Barr discloses switching between modulation types. *Id.* at 29 (citing Ex. 1005, 1:57–63, 2:3–13, 3:37–42, 3:53–55, 5:13–17, 8:54–58, 12:1–21, 13:5–7).

Petitioner argues that Hofstetter's control unit 3 controls modulation of light from Hofstetter's laser. Pet. 30 (quoting Ex. 1006, 4:5–11). Petitioner further asserts that control unit 3 has a mode that phase modulates light from the laser (i.e., the mode created by the control signals in row 5 of Hofstetter Figure 2). *Id.* at 31. With those control signals, Hofstetter outputs a PSK (phase shift key) modulated signal. *See* Ex. 1006, Fig. 2. Petitioner further argues that the control signals in row 5 phase modulate the light as a function of a digital intelligence signal, which can be a data

signal. *Id.* at 32–33 (citing Ex. 1006, 2:46–48, 4:51–53, 4:56; Ex. 1003 ¶¶ 71–73, 77).

Petitioner argues that an ordinarily skilled artisan would have implemented a composite controller in the First Modified Optical Transmitter that would include Barr’s microprocessor 30, memory 5, and switching circuitry 25, and Hofstetter’s control unit 3. Pet. 33. Petitioner further asserts that, with this composite controller, microprocessor 30 would determine a modulation technique, and switching circuitry 25 would send a signal to Hofstetter’s control unit 3 indicative of the determined modulation technique. Pet. 33–34 (citing Ex. 1005, 5:6–45, 8:49–51). According to Petitioner, Hofstetter’s control unit 3 would provide control signals to Hofstetter’s optical modulator 2 and/or light source 1, according to the determined modulation technique. *Id.* at 34 (citing Ex. 1006, 4:5–11, 5:31–36, 7:8–16; Ex. 1003 ¶ 83). Further, Petitioner argues that in one mode, the composite controller would decide to perform phase modulation and switching circuitry 25 would send a signal indicating that choice to Hofstetter’s control unit 3. *Id.* at 35 (citing Ex. 1005, 5:10–36, 8:49–51). Further, Petitioner asserts that control unit 3 would send a voltage signal to the optical modulator 2, causing the modulator (acting as a phase modulator) to phase-modulate light from the laser. *Id.* (citing Ex. 1006, 4:47–49, 7:8–16, Fig. 2 (Row 5)). Petitioner’s arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 87–89, 92–93, 95.

As discussed in Section II.C.2.d.iii., Patent Owner disputes that (i) Hofstetter teaches a phase modulator for phase modulating light from a light source and (ii) thus that the First Modified Optical Transmitter would contain such a phase modulator. As also discussed in Section II.C.2.d.iii.,

we disagree with Patent Owner on these issues and found that Hofstetter teaches a phase modulator for phase modulating light from a light source and that the First Modified Optical Transmitter would have contained such a phase modulator. Patent Owner raises no other issues regarding this first-mode limitation. PO Resp. 8–27. After reviewing the record, we determine that Petitioner has proven that Hofstetter teaches a controller in a first mode controlling the phase modulator so as to create phase-modulated optical signals in the light from the laser as a function of the electronic data stream and that the First Modified Optical Transmitter would have such a controller. *See* Section II.C.2.d.iii.

vi. the controller in a second alternate mode amplitude-modulating the light from the laser as a function of the electronic data stream

Petitioner argues that, in a second mode, Barr’s controller amplitude-modulates light by sending a signal that causes characteristic controller 110 to implement an amplitude modulation technique. Pet. 29 (citing Ex. 1005, 2:3–14, 2:25–28, 4:62–65, 5:6–45, 8:46–54; Ex. 1003 ¶ 61). Petitioner further asserts that this amplitude modulation is a function of an electronic data stream. *Id.* at 30 (citing Ex. 1005, 6:41–42, Fig. 1).

Petitioner argues that, in a second mode, Hofstetter’s control unit 3 amplitude-modulates light via first and second control signals. Pet. 30 (citing Ex. 1006, 4:5–11, 4:47–56; Ex. 1003 ¶ 69). According to Petitioner, rows 1, 3, and 8 of the table of Hofstetter Figure 2 specify control signals for this second mode. *Id.* at 31–32. Petitioner argues that the specified amplitude modulation is a function of an electronic data stream, quoting: “Rows 1 to 9 of the table [of Fig. 2] show possible combinations to obtain light at the output 5 which is modulated with a digital intelligence signal.”

Id. at 32–33 (quoting Ex. 1006, 4:51–53) (emphasis and bracketed text added by Petitioner). Petitioner also quotes Hofstetter’s disclosures that (i) “[l]ight emerging at an output of the *modulator is modulated by the intelligence signal*,” and (ii) “[a]n intelligence signal can be . . . a data signal.”) *Id.* at 33 (quoting Ex. 1006, 2:46–48, 4:56) (emphasis added by Petitioner).

As discussed in Section II.C.2.e.3, Petitioner argues that an ordinarily skilled artisan would have implemented a composite controller in the First Modified Optical Transmitter. Pet. 33. Petitioner further asserts that, in that controller, microprocessor 30 would determine a modulation technique, and switching circuitry 25 would send a signal to Hofstetter’s control unit 3 indicating the determined modulation technique. Pet. 33–34 (citing Ex. 1005, 5:6–45, 8:49–51). Petitioner further contends that Hofstetter’s control unit 3 would provide control signals to Hofstetter’s optical modulator 2 and/or light source 1, according to the determined modulation technique. *Id.* at 34 (citing Ex. 1006, 4:5–11, 5:31–36, 7:8–16; Ex. 1003 ¶ 83). According to Petitioner, in one mode, the composite controller would choose amplitude modulation, and switching circuitry 25 would signal that choice to Hofstetter’s control unit 3. *Id.* at 35 (citing Ex. 1005, 5:10–36, 8:49–51). Petitioner asserts that control unit 3 would send a current signal to the laser in light source 1, causing the laser to amplitude modulate its output light. *Id.* (citing Ex. 1006, 4:58–67, 6:58–65, Fig. 2 (Row 1)). According to Petitioner, alternatively in this mode, control unit 3 would send a voltage signal to modulator 2, causing the modulator 2 to amplitude modulate the laser light. *Id.* (citing Ex. 1006, 5:4–13, 6:67–7:7,

Fig. 2 (Row 3)). Petitioner's arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 68–72, 75, 77–78.

Patent Owner does not dispute Petitioner's showing regarding this second-mode limitation. PO Resp. 8–27. After reviewing the record, we determine that Petitioner has proven that the composite controller in the First Modified Optical transmitter is a controller in a second alternate mode amplitude-modulating the light from the laser as a function of the electronic data stream.

vii. the first mode and the second mode occurring at different times.

Petitioner argues that Barr discloses its phase-modulation and amplitude-modulation modes occur at different times. Pet. 37. According to Petitioner, Barr switches its modulation techniques at intervals, e.g., switching between phase modulation and amplitude-modulation. *Id.* Petitioner quotes the following disclosures:

- (i) The characteristics of the transmitted data which may be varied . . . include . . . the modulation technique (for example, AM, FSK, PM or QAM) (Ex. 1005, 2:3–13);
- (ii) The characteristics of the communications channels are varied by selecting ... the particular transmission protocol to be used at any one time. At intervals, for example, at random intervals, the transmission protocol is changed (*id.* at 1:57–63);
- (iii) A change will be made from one configuration to another configuration rapidly and preferably at frequent random time intervals (*id.* at 3:53–55);
- (iv) means for changing the configuration of the information message signal to be transmitted at

random time intervals (*id.* at 13:5–7 (attributed by Petitioner to 5:13–17)); and

(v) the apparatus of the present invention [can] switch rapidly and accurately from one modulation technique to another (*id.* at 8:54–58).

Id. at 37–38. Petitioner further argues that an ordinarily skilled artisan would have found it obvious for the first and second modes to occur at different times in the First Modified Optical Transmitter to retain the advantages of Barr’s switching between modulation techniques, namely, “preventing an unauthorized person from intercepting the data transmitted over the communications channel.” *Id.* (quoting Ex. 1005, 1:64–66, 4:33–36, citing Ex. 1005, 1:9–68; Ex. 1003 ¶¶ 87–89). Petitioner’s arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 87–89.

Patent Owner does not dispute Petitioner’s showing regarding this limitation. After reviewing the record, we determine that Petitioner has proven that the First Modified Optical Transmitter would have its first and second mode occurring at different times.

viii. Summary

Petitioner has proven that claim 1 would have been obvious over Barr and Hofstetter.

e. Claim 2: The transmitter as recited in claim 1 wherein the controller in the second mode amplitude modulates the light in direct relation to the input data stream.

The parties dispute whether Barr and Hofstetter teach the above limitation of claim 2. Pet. 38–39; PO Resp. 38–41.

In asserting that claim 2 would have been obvious over Barr and Hofstetter, Petitioner relies on its proposed construction for the phrase “in

direct relation to the input data stream,” which is “amplitude modulating light as a function of the input data stream without using an output of a delayed-feedback exclusive-or gate.” Pet. 9, 38–39. Petitioner argues that “[n]either Barr nor Hofstetter disclose a delayed-feedback exclusive-or gate,” that the First Modified Transmitter also would have lacked such a gate, and, therefore, the First Modified Transmitter’s controller in the second mode would have amplitude modulated the light in direct relation to an input data stream, as recited in claim 2. *Id.* at 38–39 (citing Ex. 1003 ¶ 86).

As discussed in Section II.B.2., Patent Owner disputes Petitioner’s proposed construction for “in direct relation to the input data stream.” PO Resp. 38–41. Patent Owner, however, does not dispute that, if Petitioner’s proposed construction were accepted, Petitioner has proven that Barr and Hofstetter teach or suggest the above limitation. *Id.* As discussed in Section II.B.2., we adopt Petitioner’s proposed construction for “in direct relation to the input data stream.”

Dr. Winter testifies that neither Barr nor Hofstetter discloses a delayed-feedback exclusive-or gate and that the First Modified Transmitter also would have lacked such a gate. Ex. 1003 ¶ 86. Patent Owner does not dispute that testimony. PO Resp. 38–41.

After reviewing the record, we determine that Petitioner has shown that the First Modified Optical Transmitter would have had a controller that in a second mode that amplitude modulates the light in direct relation to the input data stream. Thus, Petitioner has proven that claim 2 would have been obvious over Barr and Hofstetter.

f. Claim 4: The transmitter as recited in claim 1 wherein the controller has a switch for switching between the first and second modes.

Petitioner argues that Barr's switching circuitry 25 switches between its first and second modes. Pet. 39 (citing Ex. 1005, 1:57–63, 3:53–55, 5:13–17, 5:30–36; 8:49–58; 9:3–11, 12:55–58, 12:60–65, 13:5–7; Ex. 1003 ¶ 64). Petitioner further argues that it “would have been obvious for the composite controller in the First Modified Optical Transmitter to have a switch for switching between first and second modes, such as Barr's switching circuitry and associated circuitry, to imbue the First Modified Optical Transmitter with the security advantages associated with switching among modulation techniques.” *Id.* at 40 (citing Ex. 1005, 1:9–68, 4:33–36; Ex. 1003 ¶¶ 91–94). Petitioner's arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 91–94.

Patent Owner does not separately address claim 4. PO Resp. 38–43. After reviewing the record, we determine that Petitioner has proven that claim 4 would have been obvious over Barr and Hofstetter.

g. Claim 6: The transmitter as recited in claim 1 wherein the switch is bit-data activated.

Petitioner argues that Barr's switching circuitry is bit-data activated. Pet. 40 (citing Ex. 1005, 3:35–36, 5:30–36, 13:25–27; Ex. 1003 ¶ 65). Petitioner further argues that “[i]t would have been obvious for the First Modified Optical Transmitter to incorporate a bit-data activated switch (i.e., switching circuitry 25) to enable microprocessor 30 to communicate a message commanding the switch to enact the determined modulation technique.” *Id.* at 41. Petitioner continues that “[m]icroprocessor control of switching would enable rapid switching at randomly determined intervals,

as taught by Barr . . . , imbuing the First Modified Optical Transmitter with the security advantages associated with such switching.” *Id.* (citing Ex. 1005, 1:9–68, 2:3–14, 3:53–59, 4:33–36, 5:4–45, 8:52–58, 12:55–58, 13:5–7; Ex. 1003 ¶¶ 93–94). Petitioner’s arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 65, 93–94.

Patent Owner does not separately address claim 6. PO Resp. 38–43. After reviewing the record, we determine that Petitioner has proven that claim 6 would have been obvious over Barr and Hofstetter.

h. Claim 7: The transmitter as recited in claim 6 wherein bit data contained in a packet activates the switch.

The parties dispute whether the combination of Barr and Hofstetter teaches the above limitation of claim 7. Pet. 41–42; PO Resp. 41–43.

The Petition argues that Barr’s switching circuitry 25 “is activated by bit data contained in a packet, i.e., by bit data contained in the configuration message.” Pet. 41 (emphasis omitted). According to Petitioner, “[t]he configuration message is a packet transmitted from microprocessor 30 to switching circuitry 25 that contains ‘a plurality of bytes of information, each byte defining one of the characteristics of the information message signal.’” *Id.* at 41–42 (citing Ex. 1005, 1:9–68, 4:33–36, 10:16–35, 13:19–28; Ex. 1003 ¶¶ 65, 93–94). Petitioner’s arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 65, 93–94.

Patent Owner argues that claim 7, with its dependency on claims 1 and 6, requires that bit data contained in a packet activates a switch in the transmitter. PO Resp. 41. Patent Owner argues that Petitioner failed to establish that its First Modified Optical Transmitter would be so activated. *Id.* According to Patent Owner, Petitioner makes no attempt to define how

an ordinarily skilled artisan would understand “a packet” consistent with the claims and Specification of the ’500 patent. *Id.* at 41–42 (citing Ex. 1001, 3:21–33, Fig. 3). Patent Owner further asserts that Petitioner relies on inherency to establish that the bit data is in a packet, but lacks credible evidence to support a finding of inherency. *Id.* at 42. Patent Owner further argues that Dr. Winters’s testimony on claim 7 is conclusory and would not support a finding of inherency. *Id.* at 42–43. Patent Owner does not provide any expert testimony to support its arguments. *Id.* at 41–43.

In its Reply, Petitioner argues that Figures 2–5 of Barr illustrate examples of bit data contained in a packet as recited in claim 7. Pet. Reply 15. Petitioner argues that these figures illustrate the same basic packet structure shown in Figure 3 of the ’500 patent. *Id.* Petitioner does not provide any additional expert testimony regarding claim 7 with its Reply. *Id.* In its Sur-reply, Patent Owner does not address this challenge to claim 7.

We credit Dr. Winter’s testimony that “Barr’s configuration message includes a packet of data bits, and specifically ‘eight bytes of information.’” Ex. 1003 ¶ 65 (quoting Ex. 1005, 10:21–23). This testimony is supported by Barr’s disclosure regarding its Figure 2 that “[a]s shown, the configuration message comprises eight bytes of information.” Ex. 1005, 10:21–23. Dr. Winters further explains how Figure 2 of Barr shows a packet of bits. Ex. 1003 ¶ 65. And Dr. Winters explains why an ordinarily skilled artisan would have retained Barr’s configuration message with its packet of bits in the First Modified Optical Transmitter. *Id.* at ¶¶ 65, 93–94.

Patent Owner does not substantively explain why Dr. Winter’s testimony that Barr’s configuration message has a packet of bits is

erroneous and, as discussed, provides no contrary expert testimony. PO Resp. 41–43. Despite the fact that Dr. Winters’ testimony on this issue relies on Barr’s express disclosures, Patent Owner characterizes this testimony by Dr. Winters as relying on allegedly inherent disclosures, but does not credibly explain why this testimony concerns inherent, rather than express, disclosures in Barr. *Id.* Patent Owner made the same characterization of this testimony in its Preliminary Response, and we disagreed with that characterization in our Institution Decision. Prelim. Resp. 37–40; Inst. Dec. 34–35. The Patent Owner Response provides no further support for its characterization of this testimony by Dr. Winters as relying on inherency. PO Resp. 41–43. Dr. Winters relies on express, not inherent, disclosures in Barr. Ex. 1003 ¶ 65 (quoting Ex. 1005, 10:21–23). And Patent Owner has not identified any credible errors in Dr. Winters’s analysis showing that Barr expressly teaches a configuration message comprising a packet of data bits that meets this limitation or presented any credible rebuttal evidence. PO Resp. 41–43.

In sum, we credit Dr. Winter’s testimony, which is supported by Barr’s disclosure and determine that Petitioner has proven that claim 7 would have been obvious over Barr and Hofstetter.

i. Claim 8: The transmitter as recited in claim 1 wherein the laser is directly adjacent the phase-modulator.

Petitioner argues that Hofstetter’s laser is directly adjacent optical modulator 2. Pet. 42 (citing Ex. 1006, 3:39–42, Fig. 1). Further, Petitioner argues that “[i]t would have been obvious to position the laser directly adjacent the phase-modulator (i.e., optical modulator 2) in the First Modified Optical Transmitter so that emitted light enters the phase-

modulator 2 for modulation.” *Id.* According to Petitioner, an ordinarily skilled artisan “would have recognized that positioning the laser directly adjacent the phase-modulator would enable a reduction in size and complexity of the transmitter.” *Id.* (citing Ex. 1003 ¶¶ 67, 81, 92).

Petitioner’s arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 67, 81, 92. Patent Owner does not separately address claim 8. PO Resp. 38–43. After reviewing the record, we determine that Petitioner has proven that claim 8 would have been obvious over Barr and Hofstetter.

j. Claim 9: The transmitter as recited in claim 1 wherein during the second mode the phase-modulator provides a constant or no phase-modulation change.

Petitioner argues that, when Hofstetter’s optical modulator performs amplitude modification (the recited second mode), Hofstetter’s phase-modulator (optical modulator 2) provides constant or no phase-modulation change. Pet. 43. Petitioner asserts that in Row 1 of Hofstetter’s Figure 2, when light from the laser is amplitude modulated, “the control voltage[] is a constant-amplitude sinusoidal signal of fixed frequency’ [quoting] (Ex. 1006, 4:65–67), which causes the phase-modulator to apply no phase-modulation change, resulting in amplitude-modulated, but not phase modulated, output signals (ASK).” *Id.* Further, Petitioner argues that an ordinarily skilled artisan would have been motivated to have the phase-modulator in the First Modified Optical Transmitter provide a constant or no phase-modulation change to obtain a purely amplitude-modulated output signal. *Id.* Petitioner’s arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 76, 88.

Patent Owner does not separately address claim 9. PO Resp. 38–43. After reviewing the record, we determine that Petitioner has proven that claim 9 would have been obvious over Barr and Hofstetter.

k. Independent Claim 17

Claim 17 is an independent method claim, which recites steps corresponding to the elements of claim 1 as set forth in the table below:

Claim 1	Claim 17
1. An optical data transmitter comprising:	17. A method for transmitting optical data in two modes comprising the steps of:
a laser; a phase modulator for phase modulating light from the light source; and	
a controller having an input for receiving an electronic data stream,	
the controller in a first mode controlling the phase modulator so as to create phase-modulated optical signals in the light from the laser as a function of the electronic data stream	phase modulating light from a laser during a first transmission mode so as to transmit phase-modulated optical data
the controller in a second alternate mode amplitude-modulating the light from the laser as a function of the electronic data stream	amplitude modulating light from the laser during a second alternate transmission mode so as to transmit amplitude-modulated optical data
the first mode and the second mode occurring at different times.	the second alternate transmission mode occurring at a time separate from the first transmission mode.

Ex. 1001, 8:27–10:22. As can be seen from the above table, claim 17 recites transmitting modulated optical data, whereas claim 1 recites a controller that creates, but does not necessarily, transmit modulated signals. *Id.* Petitioner argues that both Barr and Hofstetter disclose transmitting phase-modulated and amplitude-modulated optical data. Pet. 45–46 (citing Ex. 1005, 2:3–13, 6:35–39, 14:5–9, 12:17–18; Ex. 1006, 6:35–29, 8:38–43; Ex. 1003 ¶¶ 52, 54–61, 67). Petitioner further argues that an ordinarily skilled artisan would have transmitted amplitude-modulated and phase-modulated light with the First Modified Optical Transmitter. *Id.* at 47. Otherwise, Petitioner relies on essentially the same disclosures and arguments for claim 17 as for claim 1. Pet. 10–38, 43–48. Petitioner’s arguments regarding claim 17 are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 52, 54–61, 67.

Patent Owner provides the same arguments for claim 17 as for claim 1. PO Resp. 7–38. After reviewing the evidence and arguments Petitioner provides that are specifically addressed to claim 17 and the evidence and arguments both parties presented regarding claim 1, we determine that Petitioner has proven that claim 17 would have been obvious over Barr and Hofstetter for the reasons previously explained in our discussion of claim 1 and due to the evidence and arguments that Petitioner provides specifically for claim 17.

l. Claim 18: The method as recited in claim 17 wherein during the first transmission mode the light is not amplitude modulated.

Petitioner argues that row 5 of Hofstetter’s Figure 2 discloses a first transmission mode where light is phase modulated (PSK modulated), but not amplitude modulated, noting that the specified laser current is constant.

Pet. 48. Petitioner further argues that an ordinarily skilled artisan would have incorporated this teaching into the First Modified Optical Transmitter. *Id.* Petitioner's arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 37, 73, 87.

Patent Owner does not separately address claim 18. PO Resp. 38–43. After reviewing the record, we determine that Petitioner has proven that claim 18 would have been unpatentable over Barr and Hofstetter.

m. Claim 19: The method as recited in claim 17 wherein during the second alternate transmission mode the light is both amplitude-modulated and phase modulated.

Petitioner argues that row 8 of the table of Hofstetter Figure 2 discloses that during the second alternate transmission mode light is both phase and amplitude modulated (QAM modulation). Pet. 48. Petitioner further argues that Row 8 of Hofstetter's Figure 2 depicts the generation of QAM output signals, which are both amplitude-modulated and phase-modulated. *Id.* Petitioner quotes the following disclosure from Hofstetter: "In the case of QAM-modulated light (row 8), one intelligence signal is represented by the intensity of the light, and the other by its phase." Ex. 1006, 5:20–23 (quoted by Pet. 49). Petitioner's arguments are supported by the testimony of Dr. Winters. Ex. 1003 ¶¶ 38–39, 77–78, 87.

Patent Owner does not separately address claim 19. After reviewing the record, we determine that Petitioner has proven that claim 19 would have been obvious over Barr and Hofstetter.

3. Asserted Obviousness Based on Sasaki and Ishii

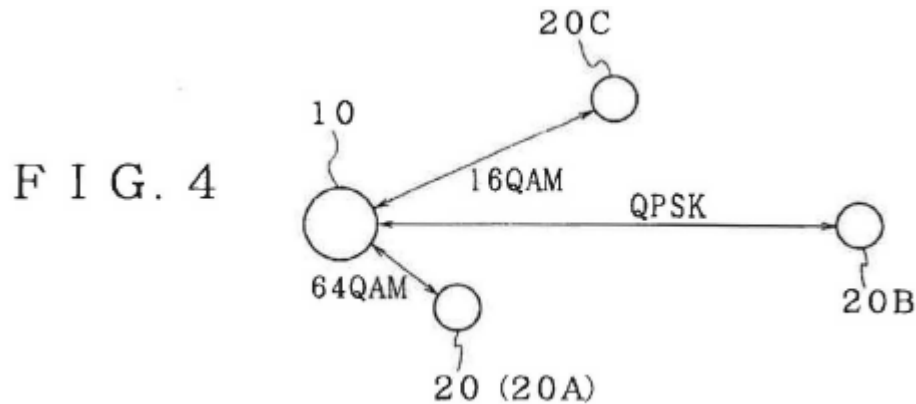
Petitioner asserts that claims 1, 2, 4, and 17–19 would have been obvious over the combination of Sasaki and Ishii. Pet. 49–72.

a. Sasaki

Sasaki is directed to “a modulating and demodulating method and a transmitting method of a control apparatus and a control apparatus.”

Ex. 1009, 1:9–11. An object of Sasaki is “to provide an optical transmission method and an optical transmission apparatus capable of transmitting data at high speed and excellently by precisely and simply restricting multiple paths.” *Id.* at 2:63–67. Sasaki describes: “a network in which optical communication using infrared ray[s] is carried out between a plurality of child nodes 20 and a parent node 10.” *Id.* at 5:61–65. In that network, “modulation sets comprising a same kind of a modulation system having different multiple value formation levels are prepared for the child nodes 20 which are control apparatuses on the controlled side.” *Id.* at 5:66–6:3. An example is the modulation set of “QPSK (quadrature phase shift keying), 16 QAM (16 quadrature amplitude modulation), 64 QAM and 256 QAM.” *Id.* at 6:3–8. “A modulation system having a low multiple value formation level is basically strong at error tolerance and a modulation system having a high multiple value formation level is weak at the error

tolerance.” *Id.* at 6:12–15. Figure 4, reproduced below, illustrates a configuration with a parent mode and three child nodes:



As illustrated, 20A and 20B are the closest and farthest child nodes, respectively, from parent node 10. Ex. 1009, 6:25–41. Because child node 20A requires fast communication and is nearest to parent node 10, it communicates using 64 QAM. *Id.* at 6:25–33. Because child node 20B is most remote, “a modulation system having a lowest multiple value formation level (QPSK) is selected [for its communications].” *Id.* at 6:39–44. “[C]hild node 20C . . . may have a moderate communication distance and may have a moderate communication speed and therefore, in [Figure 4, it has] a modulation system of 16 QAM.” *Id.* at 6:46–50. Further, “child node 20C is installed with modulating means realizing two kinds of modulation systems of QPSK and 16 QAM.” *Id.* at 6:50–52. Parent node 10 is “installed with modulating means and demodulating means in correspondence with the modulation system of the child node 20 having the highest multiple value formation level, or in this example, 64 QAM and the modulation systems at an order of a layer lower than 64 QAM (16 QAM and QPSK).” *Id.* at 6:55–61.

The modulation mode of a child node can be statically or dynamically selected (Ex. 1009, 7:5–9), and “the modulation system of the parent node 10 is switched . . . such that [it] . . . becomes equal to the modulation system of the child node 20 constituting the counterpart of communication” (*id.* at 7:13–19). With dynamic selection, “the respective child nodes 20 can select the modulation systems which are different from each other depending on the purpose.” *Id.* at 7:20–25. In addition:

when a communication position of the child node 20 is changed relative to the parent node 10, [and] . . . the communication distance of the child node 20 relative to the parent node 10 is prolonged, . . . the modulation system is dynamically changed to that having a lower multiple value formation level such [as changing from] 64 QAM to 16 QAM to QPSK.

Id. at 7:26–32. As a result, “regardless of the communication distance, communication having excellent communication quality or a bit error rate can always be provided.” *Id.* at 7:33–35. Further, “the communication distance and the communication speed can be selected and therefore, communication having flexibility can be realized and as a result, communication range of the child node 20 can be expanded.” *Id.* at 7:35–40.

Figure 7, reproduced below, shows a wireless communication network (Ex. 1009, 8:41–45):

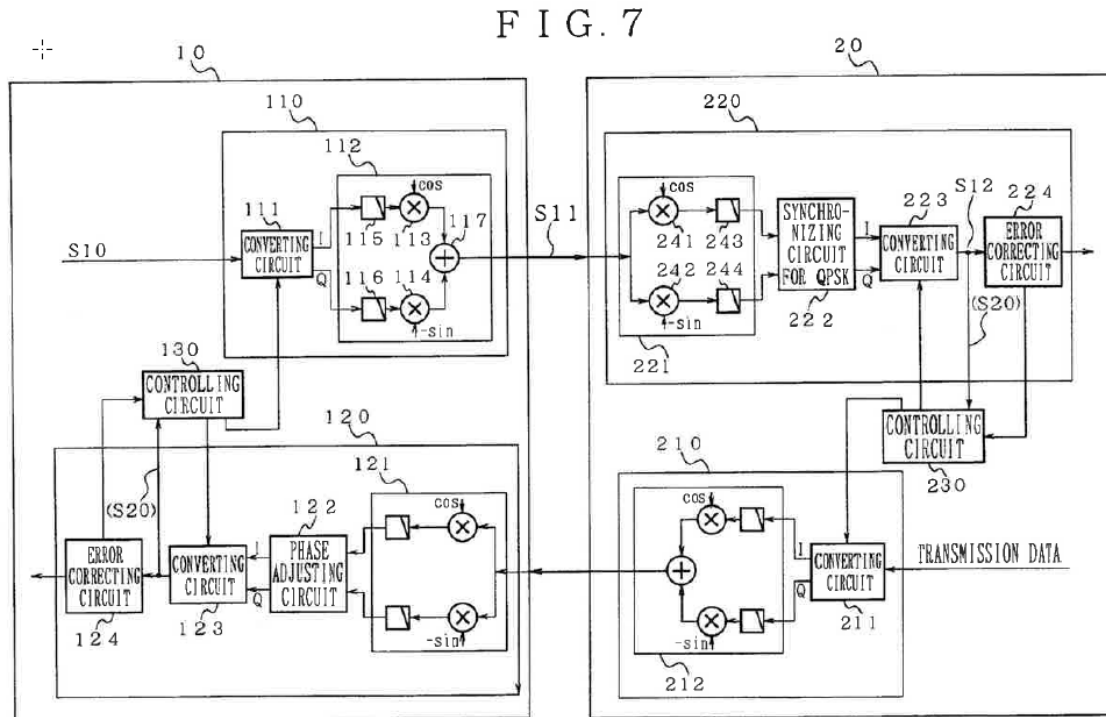


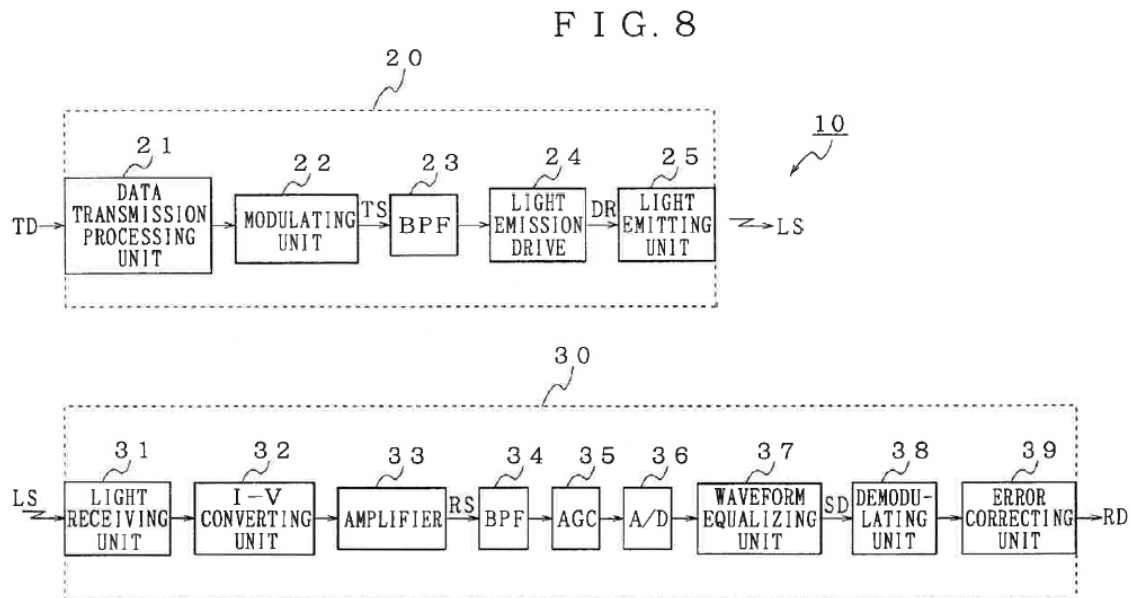
Figure 7 illustrates an embodiment with communication between parent node 10 and control node 20. *Id.* at 8:42–45. As illustrated, in parent node 10, transmission data S10 is input to converting circuit 111 of transmitter 110. *Id.* at 8:46–48. Converting circuit 111 converts the transmission data S10 into data having two quadrature components of same phase[,]
 component I and a quadrature component Q. *Id.* at 8:48–51. “In the case of QPSK conversion, I and Q respectively have two values.” *Id.* at 8:51–52. “[I]n the case of 16 QAM[,]
 they [have] four values, in the case of 64 QAM, they [have] eight values[,]
 and in the case of 256 QAM, they [have] sixteen values.” *Id.* at 8:53–55.

Controlling circuit 130 instructs converting circuit 111 which conversion to use. Ex. 1009, 8:56–58. Quadrature modulator 112 performs quadrature modulation on the converted I and Q signals. *Id.* at 8:61–63. The quadrature modulated I and Q signals are added together by adder 117, and the added signal is supplied to a light emitting means (not illustrated). *Id.* at 9:1–4. Infrared ray S11 is transmitted to child node 20. *Id.* at 9:5–7.

Child node 20 includes a light receiving element (not illustrated in Figure 7), which receives infrared ray S11 and converts it into a reception level that is provided to quadrature demodulator 221 in receiver 220. Ex. 1009, 9:8–12, Fig. 7.

Child node 20 also has transmitter 210, which is similar to transmitter 110. Ex. 1009, 9:38–43. “Data to be transmitted at the transmitter 210 is supplied to a converting circuit 211 and converted into two quadrature components I and Q signals [,] and the I and Q signals are subjected to quadrature modulation at a quadrature modulator 212.” *Id.* at 9:43–48. “Thereafter, a light emitting element is excited and infrared ray is transmitted to the side of the parent node 10.” *Id.* at 9:48–49. “The modulation system is instructed by a controlling circuit 230 built in CPU.” *Id.* at 9:50–51.

Figure 8, reproduced below, “shows a constitution of an optical transmission apparatus expressing the function blocks of FIG. 7 and added with an optical transmission unit” (Ex. 1009, 12:56–58):



As illustrated in Figure 8, optical transmission apparatus 10 includes transmitter 20 and receiver 30. Ex. 1009, 12:58–63. Transmitter 20 receives transmission data (TD) via data transmission processing unit 21, which adds an error correction code and passes the data to modulating unit 22, which performs quadrature conversion of the signal, producing transmission signal TS. *Id.* at 12:58–13:2. Band pass filter 23 filters the signal and provides it to light emission drive 24, which forms drive signal DR, which drives light emitting unit 25 to emit optical signal LS. *Id.* at 13:2–8.

Light receiving unit 31 in receiver 30 receives optical signal LS. Ex. 1009, 13:8–12. After the signal passes through elements 32–38, error correcting unit 39 produces correct reception data RD, which is output from receiver 30. *Id.* at 13:25–30.

b. Ishii

Ishii describes “a new coherent fiber-optic microcellular radio communication system using a novel RF-to-Optic conversion scheme.” Ex. 1010, 2241. In that system, “a radio signal is converted into an optical signal with the same modulation format coherently transmitted through a wide-band optical fiber without any baseband demodulation and modulation.” *Id.* Ishii describes converting “a qua[]ternary phase shift keying (QPSK) or quadrature amplitude modulated (QAM) radio signal . . . into an optical QPSK or QAM signal.” *Id.*

Ishii reports that “RF-to-Optic conversion . . . is considered to have almost the same insertion loss and efficiency as conventional external electro-optical modulators.” Ex. 1010, 2242. And Ishii discloses advantages to its RF-to-Optic conversion: “the RF-to-optic link conversion is easily obtained” and “transmission performances are improved because . . . the signal power is . . . concentrated on one sideband.” *Id.* In addition, Ishii indicates its “system is superior to the fiber-optic radio communication system using conventional coherent analog optical links” regarding “carrier-to-noise power ratio (CNR) performance” and “symbol error rate (SER) performances” for QPSK and QAM transmissions. *Id.* at 2241.

Figure 3, reproduced below, shows a configuration of Ishii's optical link (Ex. 1010, 2243):

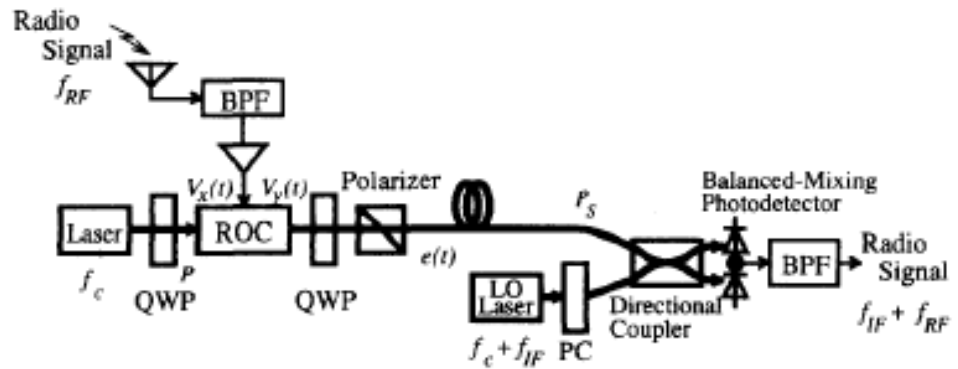


Fig. 3. Configuration of the optical link.

As illustrated, the link has a laser, two quarter wave plates (QWP), a band pass filter (BPF), and a RF-to-Optic converter (ROC). *Id.* at Fig. 3.

c. Proposed Combination

Petitioner argues that an ordinarily skilled artisan would have incorporated a laser and an RF-to-Optic converter as taught by Ishii into

transmitter to provide high quality communication.⁹ Pet. 56. Citing Kitajima (Ex. 1018), Petitioner argues that the advantages of external modulation is that it can reduce spectrum spreading (chirping) and by so doing contribute to the maintenance of a high-quality signal. *Id.*

Patent Owner argues that the chirping disclosed by Kitajima would not be an issue for Sasaki's light emitting unit. PO Resp. 54. Patent Owner asserts that Kitajima teaches that suppressing chirp is important to protect against waveform dispersion "when an optical signal of high intensity is transmitted over a long distance through an optical fiber which scarcely attenuates the signal." *Id.* at 59 (quoting Ex. 1018, 1:14–25). Patent Owner argues that none of these characteristics exist in Sasaki, which is directed to free space transmissions using, e.g., infrared light, with a transmission range between the light emitting unit and a light receiving unit of 1,000 centimeters. *Id.*

Petitioner argues that chirp is relevant in free space optical communications systems, and external modulation was known to reduce chirp for such systems. Pet. Reply 25. Petitioner also argues that Dr. Winters testified that Sasaki's disclosure is relevant to distances longer than the particular examples given in Sasaki. *Id.* Further, Petitioner argues that chirp is relevant to implanting long distance, fiber based communications based on a combined Sasaki-Ishii system. *Id.*

⁹ Petitioner also argues that an ordinarily skilled artisan would have been motivated to incorporate a laser into Sasaki's light emitting unit. Pet. 57. Petitioner's reasons for integrating a laser with Sasaki's light emitting unit, however, are distinct from those for incorporating an ROC. *Id.*; PO Resp. 60; Pet. Reply 25.

Patent Owner responds, arguing that Kitajima's disclosures are focused on fiber-based, long distance transmissions, where Sasaki is focused on short-range, free space transmissions. Sur-reply 17. Patent Owner also argues that Petitioner relies on Chan (Ex. 1027), submitted with its Reply to support its motivation to combine, but Chan confirms mandatory design aspects that would discourage an ordinarily skilled artisan from using Sasaki's system in combination with Ishii to form a long-distance fiber-based communication combination. *Id.* at 18.

ii. Expert Testimony

In his First Declaration, which was submitted with the Petition, Dr. Winters testifies that an ordinarily skilled artisan would have been motivated to create the Second Modified Optical Transmitter to obtain advantage associated with external modulation of avoiding or minimizing chirp. Ex. 1003 ¶ 141. Dr. Winters testifies:

The use of external modulation in a transmission system can prevent spectrum spreading, which is sometimes referred to as "chirp." The avoidance of chirp that is enabled by external modulation in a transmission system can enhance the quality of the transmitted signal. This is explained, for instance, in Kitajima, which notes that "external modulation system is less susceptible to the chirping." Kitaj[i]ma (EX1018), 1:22-23. A POSITA, recognizing the chirp reduction available by external modulation, would have been motivated to implement Sasaki's external modulation scheme in the Second Modified Optical Transmitter.

Ex. 1003 ¶ 142.

Mr. M^cAlexander, in his Declaration, which was submitted with the Patent Owner Response, testifies that an ordinarily skilled artisan "familiar

with Sasaki would recognize that Kitajima's concern about chirp is irrelevant to Sasaki's system." Ex. 2005 ¶ 82. Mr. M^cAlexander further testifies that Kitajima teaches that suppressing chirp is important for particular optical signals transmitted over large distances with optical fibers, which is not the transmissions that Sasaki is directed to:

According to Kitajima, suppressing chirp is important to protect against waveform dispersion "when an optical signal of high intensity is transmitted over a long distance through an optical fiber which scarcely attenuates the signal." None of these characteristics exist in Sasaki, which is directed to free space transmissions using, e.g., infrared light, and not transmissions through an optical fiber. Further, Sasaki is directed to a transmission range between the light emitting unit and a light receiving unit of 1,000 centimeters.

Id. (footnotes omitted).

Mr. M^cAlexander further testifies that:

A POSITA would realize from the transmission distances in Sasaki that Kitajima's perceived warning about long distance transmissions are inapplicable to Sasaki's system. Sasaki's transmissions are too short to raise the concerns identified in Kitajima. Because Kitajima's teachings regarding chirp do not apply to Sasaki, a POSITA faced with Sasaki would not be motivated to seek out external modulation to solve a problem ("chirp") that does not exist in Sasaki.

Ex. 2005 ¶ 83 (footnote omitted).

Dr. Winters's Supplemental Declaration, which was submitted with Petitioner's Reply, does not address the above testimony by Mr. M^cAlexander. Ex. 1026, generally. Petitioner's Reply, however, cites to

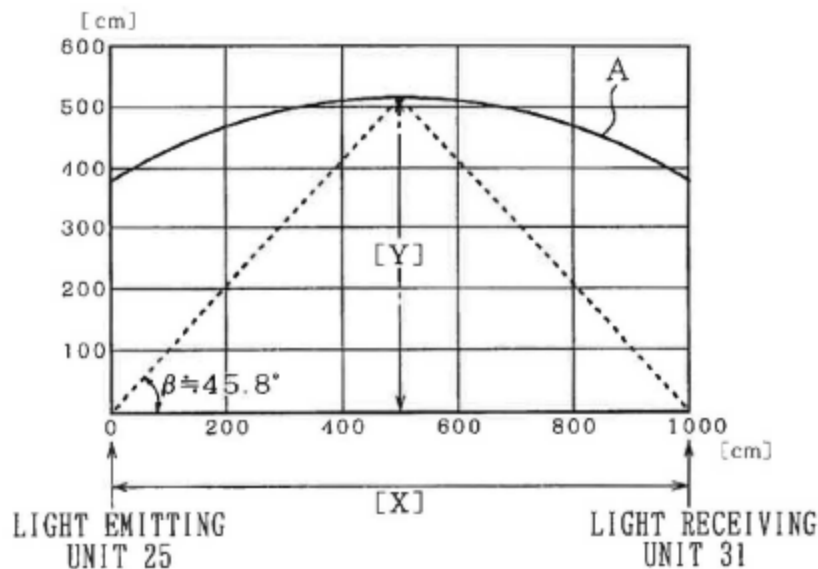
re-direct testimony Dr. Winters provided for his First Declaration regarding whether Sasaki's disclosure could be used for distances longer than the particular examples given in Sasaki. Pet. Reply 25 (citing Ex. 2004, 172:15–174:11). The Reply also cites cross-examination testimony from Dr. Winters for his First Declaration that addresses whether Sasaki's disclosure would be relevant to fiber optical communications. Pet. Reply 25 (quoting Ex. 2004, 122:25–123:4).

iii. Analysis

We determine that Petitioner has not proven that an ordinarily skilled artisan would have combined Ishii's ROC with Sasaki's light emitting unit. The reason Petitioner gives for incorporating Ishii's ROC into Sasaki's light emitting unit is to provide external modulation to, as taught by Kitajima, avoid chirping. Pet. 56–57. We credit Mr. M^cAlexander's testimony that an ordinarily skilled artisan would recognize that Sasaki's system, as disclosed, would not have the chirping issues identified by Kitajima. Ex. 2005 ¶ 82. As Mr. M^cAlexander testifies, Kitajima discloses that chirping can be an issue “when an optical signal of high intensity is transmitted over a long distance through an optical fiber which scarcely attenuates the signal.” Ex. 1018, 1:14–20, *see also* 1:21–25 (“so-called chirping”); Ex. 2005 ¶ 82. Kitajima teaches that, for such transmissions, external modulation can reduce chirping. Ex. 1018, 1:31–33. We, however, further credit Mr. M^cAlexander's testimony that an ordinarily skilled artisan would recognize that Sasaki does not teach or suggest such transmissions. Ex. 2005 ¶ 82. Mr. M^cAlexander testifies Sasaki “is directed to free space transmissions using, e.g., infrared light, and not transmissions through an optical fiber.” *Id.* As Mr. M^cAlexander further

testifies, “Sasaki is directed to a transmission range between the light emitting unit and the light receiving unit of 1,000 centimeters.” *Id.* Sasaki’s disclosure supports this testimony. The horizontal axes in the graphs of Figures 21, 23, 25, 27, 29, 31, 33, and 35 all indicate that Sasaki’s light emitting unit 25 is 1000 cm from its light receiving unit 31. Ex. 1009, Figs. 21, 23, 25, 27, 29, 31, 33, 35. For illustration, Figure 21 of Sasaki is reproduced below:

F I G. 2 1



Ex. 1009, Fig. 21. Figure 21 is a diagram showing a restriction angle. *Id.* at 5:45. The horizontal (x) axis in that figure shows that light emitting unit 25 is 1000 cm from light receiving unit 31. *Id.* at Fig. 21. Petitioner has not identified any transmission distances disclosed in Sasaki of more than 1000 cm. Pet. Reply 24–25. Further, when asked during cross-examination, Dr. Winters acknowledged that he does not recall seeing any transmission distances of more than 1000 cm in Sasaki. Ex. 2004, 114:1–5.

Further, supporting Mr. McAlexander's testimony, Sasaki discloses the use of infrared light for transmissions. Ex. 1009, 9:18–22 (“infrared ray S11”). And Petitioner does not dispute that Sasaki does not disclose optical fiber transmissions. Pet. Reply 24–25. Thus, the record supports Mr. McAlexander's testimony that chirping would not be an issue for Sasaki's system and, therefore, an ordinarily skilled artisan would not have been motivated to add external modulation to Sasaki to avoid chirping.

As mentioned, Petitioner argues that that chirp is relevant to Sasaki's free-space transmissions, and external modulation was known to reduce chirp for such systems. Pet. Reply 25. Petitioner, however, provides no expert testimony to support that assertion. *Id.* Petitioner instead relies on attorney argument interpreting a passage in Chan (Ex. 1027), noting Chan discloses that on the transmitter side of its system “[a] separate external modulator is used to reduce chirp.” *Id.* Petitioner, however, provides no explanation of how the system disclosed in Chan relates to the system shown in Sasaki nor does Petitioner address whether Chan is a special case. The quote itself provides no indication that chirp in Chan's free space system would manifest itself with Sasaki's system or that an external modulator would reduce chirp in Sasaki's system.

As mentioned, Petitioner also argues that Sasaki's disclosure is relevant to distances longer than the particular examples given in Sasaki. *Id.* Petitioner cites the following testimony Dr. Winters provided on redirect examination regarding his First Declaration:

Q Do you recall testifying earlier today about the distance between the nodes disclosed in Sasaki's system?

A Yes.

Q I believe you testified about a distance between the nodes being disclosed at 1,000 centimeters; is that correct?

A The figures, as pointed out by opposing counsel, showed that the figures, for example, Figure 21, were showing distances up to a thousand centimeters.

Q. I believe you testified that in the Sasaki system, you could consider other lower level modulation techniques that could achieve longer distances.

Do you recall that?

[objections omitted]

THE WITNESS:

My prior testimony was that you could go longer distances by transmitting more power. You can also go longer distances potentially by using lower level modulation techniques or a higher level of encoding.

[counsel name omitted]

Q Are those techniques within the understanding of a person of skill in the art reading Sasaki, in your opinion?

[objections omitted]

THE WITNESS:

A POSITA would understand what I just stated there that the distances could indeed exceed what Sasaki was talking about, again, by transmitting additional power so that the signal-to-noise ratio would still be in the correct range as, for example, shown in Figure 19.

Even at longer distances and they could also understand that like in Figure 19, which only goes down to QPSK, he's talking about the performance of uncoded QPSK, and if he added coding or other types of modulation techniques that have a lower

power spectral density that, in fact, you could -- or bandwi[d]th efficiency that you could, in fact, go longer distances.

Ex. 2004, 172:15–174:11.

This testimony merely expresses what an ordinarily skilled artisan could do, not what that artisan would be motivated to do. In other words, Dr. Winters testifies that an ordinarily skilled artisan could modify Sasaki to create a situation where chirping could take place. But chirping is undesirable. Ex. 1003 ¶ 142; Ex. 2005 ¶ 80. Dr. Winters's above quoted testimony does not explain why an ordinarily skilled artisan would want to modify Sasaki so that its transmissions reach such a length that would involve undesirable chirping and hence motivate an ordinarily skilled artisan to make Petitioner's proposed modification.

Further, Petitioner argues that chirp is relevant in the context of implementing long-distance fiber-based communication. Petitioner relies on the following cross examination testimony of Dr. Winters:

Q So we would not look to Sasaki to teach us about how to select modulation techniques for fiberoptic communications; right?

A That, I would disagree with.

Pet. Reply 25 (quoting Ex. 2004, 122:25–123:4). With this testimony, Dr. Winters expresses his opinion that an ordinarily skilled artisan could look to Sasaki for modulation techniques for fiber optic communications. That testimony does not indicate that an ordinarily skilled artisan *would* use Sasaki for *long-distance* fiber communications that would give rise to chirping and hence motivate the use of an external modulator. At most, the cited testimony merely addresses fiber optic communications, which could

be communications over shorter distances, comparable in length to the transmissions disclosed in Sasaki. Further, Dr. Winters does not provide a basis for this opinion, so to the extent it could be read to support Petitioner's position now that opinion is entitled to little weight, particularly when Petitioner could have attempted to provide such a basis in Dr. Winters' redirect testimony or in his Supplemental Declaration. Ex. 2004, 122:25–123:4.

In sum, we credit Mr. McAlexander's testimony that an ordinarily skilled artisan would not have been motivated to modify Sasaki to add external modulation to avoid chirping. Ex. 2005 ¶¶ 82–83. Thus, Petitioner has not proven that an ordinarily skilled artisan would have combined Sasaki and Ishii to make its Second Modified Optical Transmitter.

e. Challenged Claims

As discussed, claims 1 and 17 are the independent challenged claims. Ex. 1001, 8:27–10:28. Claim 1 recites: “a phase modulator for phase modulating light from the light source.” *Id.* at 8:27–41. Claim 17 recites: “phase modulating light from a laser during a first transmission mode so as to transmit phase-modulated optical data.” *Id.* at 10:14–16. For each of these limitations, Petitioner relies on its proposed combination of Ishii's ROC with Sasaki's light emitting unit. Pet. 59–61, 70–71. Because Petitioner has not proven that an ordinarily skilled artisan would have combined Ishii's ROC with Sasaki's light emitting unit, Petitioner has not proven that claims 1 and 17 would have been obvious over Sasaki and Ishii.

Claims 2 and 4 each depend directly from claim 1, and claims 18 and 19 each depend directly on claim 17. Ex. 1001, 8:27–10:28. For the limitations that claims 2 and 4 incorporate by dependency from claim 1,

Petitioner relies on its showing for claim 1. Pet. 69–71. For the limitations that claims 18 and 19 incorporate from claim 17 by dependency, Petitioner relies on its showing for claim 17. Pet. 72. Thus, Petitioner has not proven that any of claims 2, 4, 18, and 19 would have been obvious over Sasaki and Ishii.

4. Asserted Obviousness Based on Sasaki, Ishii, and Davarian

Petitioner asserts that claim 5 would have been obvious over the combination of Sasaki, Ishii, and Davarian. Pet. 72–74. Claim 5 depends on claim 4, which depends on claim 1. Ex. 1001, 8:27–53. For the limitations that claim 5 incorporates through dependency from claims 1 and 4, Petitioner relies on its showing regarding the alleged obviousness of claims 1 and 4 over Sasaki and Ishii. Pet. 72–74. As discussed in Section II.C.3.e., Petitioner relies on its proposed combination of Ishii’s ROC with Sasaki’s light emitting unit for the limitation of a phase modulator for phase modulating the light from the light source, as recited in claim 1. Pet. 59–61. For that limitation, Petitioner does not rely on Davarian. *Id.* at 59–61, 72–74. Thus, because Petitioner has not proven that an ordinarily skilled artisan would have combined Ishii’s ROC with Sasaki’s light emitting unit, Petitioner has not proven that claim 5 would have been obvious over Sasaki, Ishii, and Davarian.

III. CONCLUSION

We reach the following conclusions:

Claims	35 U.S.C. §	Reference(s)	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 2, 4, 6–9, 17–19	103(a)	Barr, Hofstetter	1, 2, 4, 6–9, 17–19	
1, 2, 4, 17– 19	103(a)	Sasaki, Ishii		1, 2, 4, 17–19
5	103(a)	Sasaki, Ishii, Davarian		5
Overall Outcome			1, 2, 4, 6–9, 17–19	5

IV. ORDER

It is:

ORDERED that claims 1, 2, 4, 6–9, and 17–19 have been shown, by a preponderance of the evidence, to be unpatentable;¹⁰

FURTHER ORDERED that claim 5 has not been shown, by a preponderance of the evidence, to be unpatentable;

FURTHER ORDERED that because this is a Final Written Decision, the parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

¹⁰ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

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